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SURFACE GEOLOGY OF BURLINGTON, IOWA.

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THE sedimentary rocks of Burlington have afforded such unrivaled facilities for the study of an extensive piscine and crinoidal fauna that attention has been almost totally diverted not only from other well represented faunal groups, but also the equally interesting stratigraphical and cenological features of that vicinity. While the palæontological researches were being so assiduously carried on, regional stratigraphy necessarily received, at divers times, more or less consideration, and is comparatively well understood. Recently a detailed investigation of the superficial deposits of the region was instituted, and a preliminary notice of the observations over a limited area is herewith presented.

The general geographical features of the annexed map have been compiled from Powers' map of the city of Burlington and a portion of the map of Des Moines county, as given in Andreas' Historical Atlas of Iowa. In a few minor particulars, observation has necessitated some corrections and additions. The hypsometrical features are approximately accurate—the contours (twenty feet apart) having been, for the most part, constructed from measured street and railway elevations, and, especially in the northern third of the area represented, from measurements personally made with level and rod. Over certain areas of limited extent estimates from points of prominence were also made. Along the eastern margins of North and Prospect hills the contours should in reality form a single line, but it has been deemed more advisable, for reasons hereafter stated,

to deviate slightly from actuality, and project the individual contours distinctly.

The drift over the region cartographically represented in Plate XXIII, exhibits only the "Lower Till"—the southern boundary of the "Upper Till," or the till of the second glacial epoch, being considerably to the northwestward. Over this portion of the state the drift is usually more or less modified superficially. The boulders contained are for the most part comparatively few and of small size; they are seldom more than five or six feet in diameter, though a few miles from Burlington one is to be seen, the diametric measurement of which is more than fifteen feet. The preglacial surface expression of the region under consideration has manifestly not been completely obliterated by glaciation and the concomitant depositions, and the present topographic features are consequently in greater or less degree dependent upon the subjacent stratigraphic rocks which make up the greater portion of the altitude of the bluffs on either side of the Mississippi river at this point. The extreme attenuation of the till over the more elevated areas, and the deep accumulations of drift materials over the less elevated places, is evidenced by numerous exposures. In the valleys of Flint, Hawkeye and other smaller creeks, the depositions of the till attain a maximum thickness in some places of seventy or eighty feet.

The city of Burlington is built upon four "hills," all of which rise to a height of nearly two hundred feet above low water[1] in the Mississippi river at that place. Perhaps five-sixths of the altitude is formed of Burlington limestone and Kinderhook shales, which along the Mississippi river at Prospect and North hills, and also some parts bordering Flint creek, rise from the water's edge in high mural escarpments.

North of Hawkeye creek is a nearly insulated plateau, all sides of which are scalloped by steep-sided ravines, very deep toward the lower extremities, but interiorly becoming quickly lessened in depth,

[1] This is the basis of all elevations given in the accompanying map, and is assumed to be 510.77 feet above the sea-level. It was determined from a line of precise levels recently run by the Mississippi River Commission up the Mississippi river from the Gulf of Mexico, which gives the elevation of the U. S. P. B. M. 14, on the north end of the east abutment of the C. B. and Q. R. R. bridge over the Mississippi river at Burlington as 171.4352 meters.

and the larger ones soon passing into small, broad, shallow drainage basins, which impart to the central portion of the plateau a characteristic, gently undulatory appearance. To the northeastward is a small subsidiary plain of subdued undulatory topography, evidently in no way dependent upon the underlying stratigraphic rocks. It rises thirty or more feet above the broad alluvial flood plain of the Mississippi river, and is divided by the Flint creek. Southwestward it passes rather abruptly into the comparatively gentle slopes of the general plateau. It manifestly occupies the preglacially corroded valley of Flint creek, and laterally rests upon the irregularly eroded slopes of the ancient water course. A section of this limited auxilliary plain exhibits the following structure: the exposure is continuous for nearly half a mile on Flint creek, and is practically similar throughout.

SECTION I.[1]

1. Course, brown, friable loam, with occasional small pebbles, gradating imperceptibly into No. 2.............................. 3 feet.
2. Yellowish-brown clay of a characteristic fissured nature; containing a few small boulders or large pebbles, in places indistinctly laminated.. 15 feet.
3. Commingled sand and gravel irregularly stratified; pebbles up to six inches in diameter, mostly rounded, erratic, but with numerous local angular flint and limestone pieces............ 10 feet.
4. Drab, homogeneous unctuous clay........................ 2 feet.
5. Coarse yellow and white sand, with a few small, erratic pebbles, everywhere quaquaversally stratified..................... 6 feet.
6. Very fine homogeneous white sand (this is not present along the entire section).. 1 foot.
7. Coarse yellow and white sand, with rounded and striated erratic pebbles up to two feet in diameter, and larger local angular fragments of flint and fossiliferous (Burlington) limestone, exposed.. 12 feet.

One mile above on Flint creek the coarse yellow sands form a conspicuous feature. A short distance further north the lower till,

[1] The several sections selected are regarded as the most typical of the numerous exposures examined, and are marked on the accompanying map.

with numerous small, rounded erratic boulders up to four feet in diameter, is well exposed in all its characteristic details. It is overlaid by six to eight feet of typical loess, containing numerous small lœsskindchen. The deposits here presented have an exposed thickness of sixty feet, and are seen to lean against the steep sides, the rather narrow gorge preglacially eroded by the waters of Flint creek to a depth of more than one hundred and thirty feet. North of Flint creek, and beyond the area represented in the annexed map, the topography in its general aspect is similar to that of the insulated plateau south. On the upper brow of the north slope of "North hill," a road cutting discloses the following arrangement:—

SECTION II.

1. Brownish-yellow clay, free from gravel, and for the most part homogeneous; gradating into No. 2.............................. 5 feet.

2. Typical ashen compact loess, containing numerous small loesskindchen and the following fossils:—

Pupa muscorum Linn.	*Succinea obliqua* Say.
Patula striatella Anth.	*Limnophysa desidiosa* Say.
Patula perspectiva Say.	*Helicina occulta* Say....... 8 feet.

3. Till with an abundance of gravel, and pebbles up to three feet in diameter, exposed.. 20 feet.

Over the entire central portions of the northern plateau the distribution of quaternary deposits is essentially the same, except the lower member suffers a considerable attenuation over the more elevated parts, sometimes being reduced to a few feet in thickness. Upon removal of the drift materials glacial scorings and striæ on the subjacent palæozoic stratum have been disclosed in various places.

South of the Hawkeye creek rises a broad elevated plain so level in many places as to be almost devoid of natural drainage. Northeastward it is scalloped by short, deep ravines, but eastward it abruptly terminates with a perpendicular declivity, washed at its base by the Mississippi river, which has evidently separated the plateau from the highland of Henderson county, Illinois. To the southward and westward this level elevated plain gradually becomes gently undulatory and finally more broken by the small tributaries of Spring creek. Northwestward it merges into the general elevated

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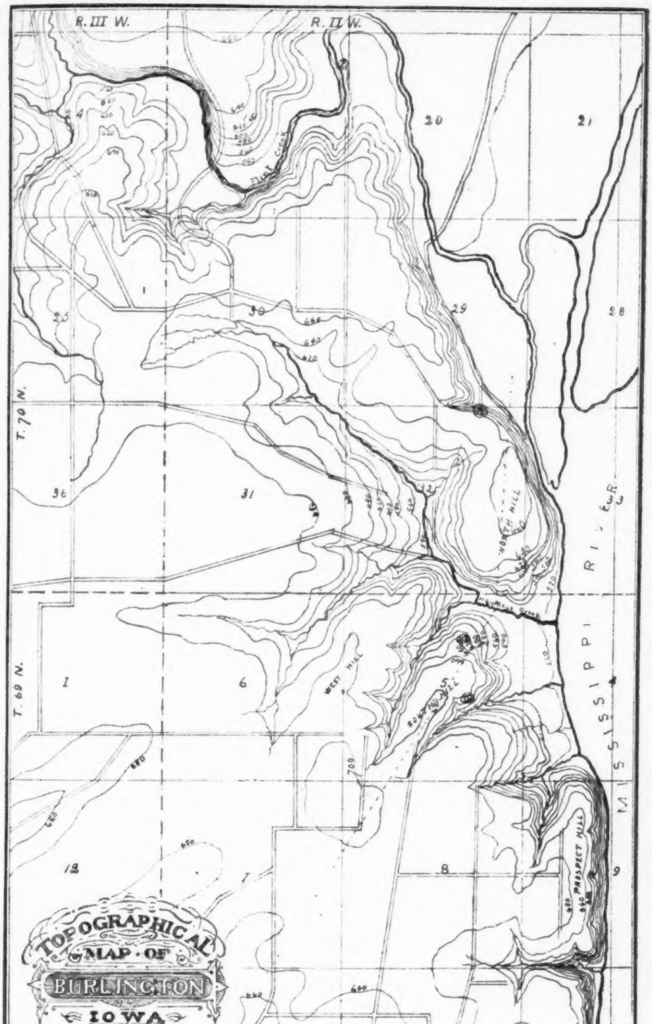
PLATE XXIII.



plain occupying the greater portion of the county. Near the summit of "South Hill" section III. is exposed in a recently opened quarry :—

SECTION III.

1. Brownish clay, free from pebbles, becoming silty below, and gradating insensibly into No. 2.. 5 feet.
2. Compact ashen loess containing lösskindchen............. 9 feet.
3. Red tenacious clay, upper portion containing much gravel, the pebbles small, rounded, mainly erratic, a few local flint and limestone fragments disseminated throughout......................... 1 foot.
4. Large angular fragments of limestone and flint, the interstices filled with red clay.. 2 feet.
5. Upper Burlington limestone, exposed.................. 20 feet.

One quarter of a mile to the southeast, on the corner of south Fourth and Maple streets, a similar arrangement is shown, superimposing the *lower* Burlington limestone. The quaternary beds of the two places are manifestly continuous, but the elevation of the latter section is somewhat less than the former, and the deposits are all intensified; No. 1 of section III. having a thickness of six feet, No. 2 of 13 feet, and Nos. 3 and 4 together, of 6 feet. Southwestward from this exposure, perhaps one-fourth of a mile, a road cutting exhibits :—

1. Brownish-clay silty or loess-like below.................. 10 feet.
2. Typical lower till... 25 feet.
3. Lower Burlington limestone, exposed.................. 5 feet.

Summarizing the observations herein briefly recorded, it is to be noted: (1) That the loess at Burlington, as in other portions of Iowa, occurs only over the elevated areas, and the fossils contained are all depauperate, evidencing, as pointed out by McGee and Call,[1] a much lower temperature of the air than at the present time, for it is also urged by those writers that the deposits of loess took place in ice-bound basins; (2) that the loess over the region under consideration has been by atmospheric agencies more or less modified superficially, often to a depth of five or six feet—the upper portion losing entirely its original character, but downward passing by insensible gradations into typical loess. This modification of the

[1] Am. Jour. Sci., Vol. XXIV., Sept., 1882.

superior portion of the löss mantle is in many respects very similar to analogous changes superficially in the aspect of the residuary clays over certain parts of the driftless area lying in the northeastern portion of the state, and the contiguous parts of Illinois and Wisconsin —more specifically referred to by Chamberlain and Salisbury;[1] (3) that the stratigraphic rocks bordering the Mississippi river suffered considerable abrasion during the sojourn of the glacier, as is attested by numerous larger fragments of flint and limestone, which are manifestly not far removed from their origin, and also by the observed surfaces of striation over the elevated portions of the area cartographically represented by fig. 1; and (4) that the till which on the retreat of the glacier nearly, if not entirely, filled preglacially corraded channels has since been more or less completely removed from the numerous deep ravines occurring on all sides of the elevated plateaus of the region.

ON THE INFLUENCE OF CIRCUMSTANCES ON THE ACTIONS AND HABITS OF ANIMALS, AND THAT OF THE ACTIONS AND HABITS OF LIVING BODIES, AS CAUSES WHICH MODIFY THEIR ORGANIZATION.

BY J. B. P. A. LAMARCK.[2]

(Continued from page 972.)

THAT which proves it, is that this is not true of the organ of hearing, which is always found in animals where the nature of their organization requires it. This is the reason. The material of sound, that which is moved by the shock or vibrations of bodies, transmits to the organ of hearing the impression which it has received from them, and penetrates everywhere, traversing all media, and even the masses of the most solid

[1] U. S. Geol. Sur., Sixth Ann. Rep.

[2] Translated by Dr. E. E. Galt, from the edition of 1809.

bodies; any animal which possesses a plan of organization in which hearing is essential, has always occasion to exercise this organ in whatever place it inhabits. Therefore, among vertebrate animals, one sees none which are deprived of the organ of hearing; but below them, when the same organ is wanting, we do not find this sense in any of the animals of succeeding classes. It is not thus with the organ of sight, for one sees that organ disappear, reappear, and disappear again, by reason of the possibility or the impossibility of the animals exercising it. In the *Mollusques acephales,* the great development of the mantle has rendered their eyes and their head altogether useless. These organs, although taking part in a wider plan of organization which comprehends them, have necessarily disappeared and become obliterated by constant disuse. Finally it enters into the plan of organization of reptiles, as of other vertebrate animals, that they should have four feet belonging to their skeletons. Serpents should have, consequently, also four feet, the more so as they do not constitute the last order of reptiles, and since they are less related to fishes than are batrachians (frogs, salamanders, etc.). Now, snakes having adopted the habit of crawling on the ground, and of hiding themselves under bushes, their bodies, in consequence of long-repeated efforts to elongate themselves, in order to pass into narrow places, have acquired a considerable length, and in no wise proportionate to their thickness. Now, feet would have been very useless to these animals, and without employment. Long feet would have been a hindrance to creeping, and very short feet, even to the number of four, would have been incapable of moving their bodies. Thus, the disuse of these parts having become constant in the races of these animals, has caused these same parts to disappear entirely, although they were really in the plan of organization of animals of their class. Many insects, which from the natural character of their order, and also of their genus, should have wings, lack them more or less completely, from disuse. Numbers of Coleoptera, Orthoptera, Hymenoptera, and Hemiptera, etc., present examples, their habits never permitting them to make use of their wings. But it is not enough to give the explanation of the cause which has brought about the condition of organs of different animals, conditions which one sees always the same in those of like species. It is necessary besides to show these

changes of conditions acting in the organs of some one individual during its life as the sole result of a great change in the habits peculiar to the individuals of its species. The following remarkable fact fully proves the influence of habits on the condition of organs, and how continued changes in the habits of an individual bring changes in the state of the organs which enter into action during the exercise of these habits. M. Tenon, member of the Institute, has communicated to the *Classe des Sciences*, that having examined the intestinal canal of many men who have been ardent drinkers during a great part of their life, has constantly found it shortened to an extraordinary degree compared with the same organ of all those who had not a like habit. It is known that great drinkers or those who are given to drunkenness, take very little solid food; that they eat almost nothing, and that the drink which they take in abundance and frequently, suffices for their nourishment. Since fluid aliment, and, above all, spiritous drinks, do not remain long either in the stomach or in the intestines, the stomach and the rest of the intestinal canal loses in drunkards the habit of distention. So also in persons of sedentary habits, and constantly applied to mental work, who habituate themselves to take very little nourishment. Gradually, in time, their stomachs contract, and their intestines become shortened. It is not a question here of shrinking and shortening produced by a contraction of parts which would permit of ordinary extension, if in place of a maintained vacancy these viscera should become filled; but it is a question of real shrinks ing and considerable shortening, so that these organs would rather burst than yield suddenly to the causes which would produce ordinary distension. Circumstances of age being entirely equal, compare a man who habitually devotes himself to studies and mental work, who has rendered his digestion sluggish, has contracted the habit of eating very little, with another who habitually and often takes much exercise and eats well; the stomach of the first would have reduced functions, and a very small quantity of aliment would fill it, whilst that of the second would be preserved and even increased. See then an organ greatly modified in its dimensions and functions by the one cause of a change in its habits during the life of the individual. The frequent employment of an organ in becoming adapted to its habits, augments the function

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PLATE XXIV.

FIG. 1.

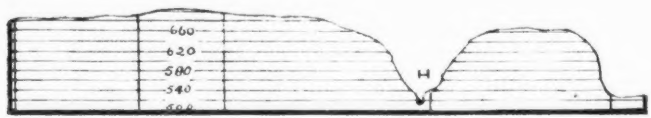

FIG. 2.

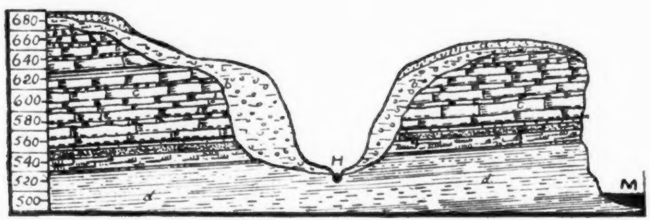

FIG. 3.
Sections at Burlington, Iowa.

of that organ, develops it, and makes it acquire dimensions and force of action which it has not in animals which exercise it less. One comes to see that the disuse of an organ which has existed, modifies, impoverishes, and finally obliterates it. I will now demonstrate that the continual employment of an organ, with the efforts made in keeping its place in the circumstances under which it exists, strengthens, extends, and increases that organ, or creates new ones which are able to exercise the functions which have become necessary.

The bird that hunger (necessity) attracts to water to find there the prey on which it lives, separates its toes and its feet when it strikes the water, and moves on its surface. The skin which unites these toes at their base, acquire the habit of extending themselves by these perpetual spreadings; thus, after a time, the large membranes are formed which we see uniting the toes of ducks, geese, etc. The same efforts made to swim, that is to say, to push the water in order to advance and move in that liquid, have developed the same membrane which is between the toes of frogs, sea-turtles, the otter, the beaver, etc. On the contrary, the bird that its manner of life habituates to roost in trees, and who proceeds from individuals who have all contracted that habit, has necessarily the toes more elongated and shaped otherwise than those of aquatic animals which I have cited. Their nails, after a time, become long, sharp, and curved in a hook by holding so often the limbs on which the animal rests. So it is known of river birds who do not swim, and who only desire to approach the borders of the water to find their prey, are continually exposed to being forced into the mud. Now this bird, wishing to act so that its body may not be wet, makes great efforts to extend and elongate its feet. It follows from the continued habits which this bird, and all those of its race have contracted in continually extending and elongating its legs, that the individuals of this race are found elevated on stilts, and have also gradually obtained long boots. That is to say, they are denuded of feathers as far as the thighs and often beyond (*Systeme des Animaux sans Vertebres*, p. 14). It is known also that the same bird, wishing to pick without wetting its body, is obliged to make continuous efforts to elongate its neck. Now, to the continuance of these habitual efforts in this individual, and those of its race, they owe that, after

a time, they acquire the singular elongation of the neck, as is seen in river birds.

If some swimming birds, as the swan and the goose, and of which the feet are short, have, nevertheless, a very long neck, it is because in walking in the water they have the habit of plunging their heads below as deeply as they are able, to take the aquatic larvæ and different animalcules which nourish them, and that they have no reason for stretching their feet. If an animal, for the satisfaction of its wants, should make repeated efforts to elongate its tongue, it would acquire considerable length (*e.g.*, the ant-eater, the "pic-verd"). If it wants to seize something with the same member, then its tongue will divide and become forked. That of humming-birds, who seize with their tongue, and of lizards and snakes, who use theirs to feel and investigate bodies which are before them, are the proofs of that which I advance. Wants, always occasioned by circumstances, and followed by continued efforts to satisfy them, are not limited in their results to modify, that is to say, to augument or diminish, the extent or the functions of these organs, but they succeed in displacing these same organs where certain of these wants make it a necessity.

Fishes which swim habitually in large bodies of water, having occasion to see laterally, have their eyes placed on the sides of the head. Their body, more or less flattened according to the species, has its edges perpendicular to the plane of the water, and their eyes are placed in such a manner that they have an eye on each flattened side. But those fishes whose habits involve the necessity of constantly approaching rivers, particularly rivers little inclined or with gentle descent, have been forced to swim with one side downwards in order to be able to approach near the edges of the water In this situation, receiving more light from above than below, and having particular reason for always being attentive to that which they find above the water, this want has forced one of their eyes to undergo a kind of displacement, and to take the very singular situation which is known in soles, turbots, "limandes," etc. (the Pleuronectes and the "Achires"). The situation of these eyes is not symmetrical, because there has resulted an incomplete mutation· Now this mutation is entirely finished in the rays, where the transverse flattening of the body is altogether horizontal; so with the

head. Thus the eyes of rays, both placed on the superior face, are rendered symmetrical.

Snakes which crawl on the surface of the earth, having reason principally to see elevated objects, or those which are above them, this necessity has influence on the situation of the organ of sight in these animals, and, in fact, it has placed the eyes in the lateral and superior part of the head, in position to perceive easily that which is above them or at their sides, but they cannot see that which is above them or but little distance in front. Now, forced to make up for the lack of sight in recognizing objects which are before them, and which might hurt them in advancing, they have been able to feel these objects only by aid of their tongue, which has obliged them to stretch it out with all their might. This habit has not only contributed to render this tongue thin, very long, and very contractile, but further, has forced it to divide itself, in a great number of species, to feel several objects at a time; it has formed an opening at the extremity of their muzzle, to pass without being obliged to open the jaws.

Nothing is more remarkable than the production of habits in herbivorous mammals. The quadrupeds to which circumstances and the wants which they have brought about, have given the habit of browsing on herbs, walk only on the earth, and find themselves obliged to rest on their four feet the great part of their life, executing generally few of the ordinary movements of other Mammalia. The considerable time which this kind of animal is forced to employ every day, to replenish itself with the only kind of food which it uses, requires that it make little movement, that it employ only its eet to sustain itself on the ground, to walk or run, and that it never exerts itself to hang to or to grasp the trees. From this habit of consuming all day, great quantities of alimentative materials which distend the organs which receive it, and of making only ordinary movements, it has resulted that the bodies of these animals are considerably thickened, become heavy and massive, and have acquired a very great volume, as one sees in the elephant, rhinoceros, cattle, buffalo, deer, etc.

The habit of resting upright on their four feet during the greater part of the day to browse, has caused a thick hoof to grow, which envelope their toes; and as these toes are resting without exercising any move-

ment, and are serving no other purpose than to sustain them as well as the rest of the foot, the greater part of them are shortened, are obliterated, and so finally disappear. Thus, in the pachyderms, some have five toes on the feet enveloped in horn, and in consequence their hoof is divided into five parts; others have only four, and others still only three. But in the ruminants, the most ancient of mammals, which are confined to sustaining themselves on the ground, there are only two toes to the feet. It is also found that there is but one toe in solipedes (the horse, the ass). Now, among these herbivorous animals, and particularly among the ruminants, it is found that, from the circumstances of the wild country which they inhabit, they are constantly exposed to become the prey of carnivorous animals, and to be able to find safety only in precipitate flight. Necessity has then forced them to exercise themselves in rapid running; and from the habit which they have acquired, their bodies have become more slight, and their limbs slenderer: one sees examples in the antelope, gazelles, etc. The deer, roe-buck, fallow-deer, etc., are exposed to perish by the chase, or pursuit by man. This risk has reduced them to the same necessity, has constrained them to the same habits, and has produced the same results in them. The ruminant animals, being able to use their feet only to sustain themselves, and having little strength in their jaws, which are used only in cropping and browsing the herbs, they are able to strike blows only with the head, directing one against the other with the top of that region. In their fits of rage, which are frequent, especially among the males, their "sentiment interieur," by these efforts directs more strongly the fluids toward that part of the head, and causes there a secretion of horny material in some, and of both osseous and horny material in others, which gives to them solid protuberances. This is the origin of horns and bosses, with which the greater number of these animals have the head armed. It is curious to observe the product of the habits in the peculiar form and the height of the giraffe (*Camelopardalis*). It is known that this animal, the tallest of mammals, inhabits the interior of Africa, and that it lives in places where the earth is almost always arid and without herbage, so that it is obliged to browse the leaves of the trees, and to force itself continually to reach them. It results from this long-continued habit, in all indi-

viduals of its race, that the front limbs have become longer than the hind ones, and that its neck is much elongated; that the giraffe, without rising on its hind feet, elevates its head and attains to six metres in height (nearly twenty feet).

Among birds, the ostriches, deprived of the faculty of flight, and elevated on very high limbs, truly owe their singular conformation to analogous circumstances. The result of habits is also as remarkable in carnivorous mammals as it is in the herbivorous, but it shows its effects in another way. In fact, those mammals who are habituated, as well as their race, to climb, to scratch, in order to excavate the earth; to rend, to attack; to put to death other animals which may be their prey, have had occasion to use their toes. Now, this habit has favored the separation of their toes, and on them has formed the claws with which we see them armed. Among the carnivores it is found that they are obliged to employ the chase to take their prey. Now, those of these animals who want, and consequently have the habit of rending with the claws, are compelled to force them deeply into the body of the other animal in order to hold it, and afterwards the effort made to tear the seized part has, by these repeated efforts, procured for those nails a size and a curve which would then have impeded them much in walking or running on stony ground. It results in this case that the animal has been obliged to make efforts to draw back these too projecting and crooked claws, and it results in, little by little, the formation of these peculiar grooves into which cats tigers, lions, etc., retract their claws when not in use. Thus, efforts in some directions, long-continued or habitually made by certain parts of a living body to satisfy wants caused by nature or by circumstances, increase these parts, and they acquire dimensions and a form which they would never have attained if these efforts had not become the habitual action of the animals which employ them. Observations made on all known animals would everywhere furnish examples of it. What is more striking than what the kangaroo offers us? This animal, which carries its little ones in the pouch which it has under its abdomen, has acquired the habit of holding itself upright, poised only on its hind feet and on its tail, and of moving only by the aid of a series of leaps, in which it preserves its upright attitude so as not to hurt its little ones.

Behold, then, what is the result? First.—Its front legs, of which it makes very little use, and upon which it supports itself only an instant when it leaves its upright attitude, have never acquired a development proportional to those of other parts, and have remained slender, very small, and almost without strength. Second.—The hind limbs, almost continually in action to sustain all the body, when leaping, have, on the contrary, attained a considerable development, and have become large and strong. Third.—Finally, the tail, which we see greatly employed in sustaining the animal, and in executing its principal movements, has acquired at its base a breadth and a force extremely remarkable. These well-known facts are assuredly well calculated to prove that which results from the habitual use by animals of an organ or of some part. If, when we observe in an animal an organ particularly developed, and strong and powerful, it is claimed that its habitual exercise has done nothing to produce that result; that its continued disuse makes it lose nothing, and that, finally, this organ has always been such as we find it since the creation of the species to which this animal belongs, I demand why our domestic ducks are not able to fly as the wild ducks; in a word, I will bring a multitude of examples to our notice, which will attest the differences resulting to us from the exercise or the lack of exercise of some of our organs, although these differences be not maintained in successive generations. In that case their results might be still more considerable. I observe, in the second place, that when the will determines an animal to some action, the organs which should execute this action are immediately excited by the influence of subtle fluids (of the nervous fluid), which becomes the determining cause of the movements which cause the action in question. A multitude of observations prove this fact. It results that the multiplied repetitions of these acts of organization strengthen, expand, develop, and also create the organs which are necessary. It is necessary only to observe attentively that which happens everywhere in this respect, to be convinced of the basis of this cause of the development of organic changes.

Now, all changes acquired in an organ in consequence of a habit employed sufficiently to have an effect, is preserved afterward by generation, if it is common to the individuals who in fecundation unite for the reproduction of their species. Finally this change is

propagated and passes thus into all the individuals which follow, and who are placed in the same circumstances, without which they would be obliged to acquire it in the same manner in which it has already been created. Moreover, in these reproductive unions, the mixture between individuals which have different qualities and forms, necessarily opposes the constant propagation of these qualities and forms.

I.—It is this which prevents in man, accidental qualities or defects due to circumstances to which he is exposed from preserving and propagating themselves by generation.

II.—If two individuals who have acquired peculiarities of form or defects be united, in this case they will reproduce the same peculiarities in successive generations. And if they restrict themselves to like unions, a particular and distinct race will then be formed. But the perpetual mixture between individuals which have not the same peculiarities of forms will destroy all the peculiarities acquired by particular circumstances. From this one can be assured that if distances of habitation had not separated men, the crossing, by generation, would have destroyed the general characters which distinguish different nations. If I should pass in review all the classes, all the orders, all the genera, and all the species of animals which exist, I would be able to show that the conformation of individuals and of their parts, that their organs, their functions, etc., etc., are everywhere only the result of circumstances in which every species finds itself surrounded by nature, and of the habits which the individuals which compose it have been obliged to adopt, and that they are not the result of an existing primitive form which has forced these animals to adopt their habits.

It is known that the animal which is called the Aï, or the sloth, (*Bradypus tridactylus*), is constantly in a state of so great feebleness that it executes very slow and limited movements, and that it walks with great difficulty on the ground. Its movements are so slow that it is claimed that it is able to take only fifty steps in a day. It is known also that the organization of this animal is in all respects harmonious with its condition of feebleness or its inability to walk, and that if it wished to make other movements than those which it is known to execute, it would not be able. If we sup-

pose that this animal has received from nature the organization which it possesses, we must believe that this organization has forced it to adopt the habits and miserable state in which it is found. I hesitate to believe thus, for I am convinced that the habits which the individuals of the race of the Aï have been forced to contract originally, have necessarily brought their organization to its present state. That since continual danger has formerly made the individuals of this species take refuge in trees, to live there habitually, and to sustain themselves there on their leaves, it is evident that they must be deprived of a multitude of movements which animals who live on the ground are in the habit of making. All the wants of the Aï have been then reduced to the hanging on the branches, to creeping, or to crawling to get the leaves, and afterwards to resting on the tree in a state of inactivity, and always to avoid falling to the earth. Besides, this kind of inactivity would be constantly encouraged by the heat of the climate; for, with animals of warm blood, heat predisposes them more to rest than to movement. Now, the individuals of the race of the Aï having for a long time preserved the habit of resting on trees, and of making only slow and little varied movements which suffice for their wants, their organization, little by little, would be brought into harmony with their new habits, and this would be the result: 1st.—That the arms of these animals making continual efforts to embrace easily the branches of the trees, will have lengthened; 2d.—That the nails of their toes will have acquired much length and a curved form by sustained efforts to cling; 3d.—That their toes, having only exercise in particular movements, will have lost all mobility, will have reunited, and will have preserved only the ability of bending or of straightening themselves altogether; 4th.—That their thighs, embracing continually the trunk and the great branches of the trees, will have contracted an habitual bowing, which will have helped to enlarge the pelvis, and to direct the cotyloid cavities backward; 5th.—Finally, that a great number of their bones will have consolidated, and that thus many parts of their skeleton will have acquired a tendency and a form appropriate to their habits, and contrary to those which they would have had under other habits.

No one is able to contest this, since nature, in a thousand other ways, constantly shows us analogous examples of the power of cir-

cumstances on the habits, and in that of habits on the forms, the disposition, and the proportion of the parts of animals. A great numder of citations being unnecessary, the point of discussion reduces itself to this. The fact is, that diverse animals have each, according to their genus and their species, particular habits, and always an organization which is perfectly in harmony with those habits. From the consideration of this fact it seems that one is at liberty to admit one or the other of the two following hypotheses, neither of which can be proved.

Conclusions admitted at this time: (1) Nature (or its Author, in creating animals has foreseen all possible kinds of circumstances in which they may have to live, and has given to each species a permanent organization, as well as a pre-determined form invariable in its parts; that it forces each species to live in the places and the climates where one finds them, and to preserve there the habits which it has. 2. My own conclusion: Nature in producing successively all species of animals, and commencing by the most imperfect or simple, to terminate its work by the most perfect, has gradually complicated their organization, and these animals, spreading themselves gradually into all habitable regions of the globe-each species has been subjected to the influence of the circumstances in which it is; and these have produced the habits which we observe and the modifications of its parts.

The first of these two conclusions is that which has been held to the present time, that is to say, it supposes in each animal a permanent organization and parts which have never varied and which will never vary; it supposes still that the circumstances of the places which each species of animal inhabits never vary in these places) for if they should vary, the same animals would not be able to live there, and the possibility of recognizing such elsewhere, and of going or transporting themselves there, would be denied them.

The second conclusion is mine. It supposes that, by the influence of circumstances on the habits and that which follows these habits on the organization, that each animal would receive in its parts and organization, modifications susceptible of becoming very cons ider able, and thus to have given origin to the state in which we find all animals. To prove that this second conclusion is without foundation, it is necessary to first prove that no point of the surface of the

surface of the globe has ever varied its nature, its exposure, its elevation, its climate, etc., etc.; and to prove farther that no part of an animal undergoes, after a length of time, any modifications due to change of circumstances and from the necessity which constrains them to a kind of life and of action different from that which has been habitual with them.

Now, if only one fact proves that an animal, after a long time of domestication, differs from the wild species from which it came, and if among the domesticated species there is found a great difference of conformation among individuals who have been subjected to a given habit, and those who have been constrained to adopt a different habit, then it will be certain that the first conclusion does not conform to the laws of nature and that, on the contrary, the second is perfectly in accord with them. All agree then to prove my assertion: that it is neither the form of the body nor of its parts which gives origin to the habits and the manner of life of the animals; but it is, on the contrary, the habits, the manner of life and all the other influential circumstances, which have, with time, constructed the form of the body and of the parts of the animals. With new forms new faculties have been acquired, and little by little Nature has come to form animals, such as we actually see them.

Can there be in Natural history a more important consideration and to which one should give more attention than that which I expound?

THE EVOLUTION OF MAMMALIAN MOLARS TO AND FROM THE TRITUBERCULAR TYPE.[1]

BY HENRY FAIRFIELD OSBORN.

THE dentition in the recent Mammalia is so diverse that the most sanguine evolutionist of fifteen years ago could not have anticipated the discovery of a common type of molar, in both jaws, as universal among the Mmamalia of an early period as the pentadactyle foot, and as central in its capacity for development into the widely specialized recent types.

The tritubercular molar, discovered by Professor Cope in the Puerco, is exactly such a type, and may be considered with the pentadactyle foot as playing a somewhat analogous rôle in mammalian history, with this important difference—the unmodified pentadactyle foot was probably inherited direct from the reptiles, and its subsequent evolution, with a few exceptions, has been in the direction of the greater or less *reduction* of primitive elements towards special adaptation, as, to borrow an extreme illustration, in the transition from *Phenacodus* with 26 elements in the manus to *Equus* with only 12 such elements. On the other hand, the tritubercular tooth was not inherited, but in all probability developed within the mammalian stock, from a hypothetical form with almost, if not quite simple conical molars, implanted by single fangs, in a nearly homodont series.[2] No such primitive type of mammalian dentition is actually known, although *Dromotherium* approximates it; but the apparent reversion to this type among the *Cetacea*, and apparent retention of it in the *Edentata*,[3] support all the independent evidence upon this point derived from the Mesozoic Mammals. The principle of growth was the regular addition of new parts to the simple cone, not at random, but according to a certain definite

[1] Read in the geological section of the British Association at Bath, September, 1888. Read in abstract by Prof. Cope, National Academy is Sciences, at New Haven, Nov., 1888.

[2] See Author "Structure and Classification of the Mesozoic Mammalia." Jour. Phila. Academy, 1888, p. 240.

[3] See Oldfield Thomas, "The Homologies and Succession of the Teeth in the Dasyuridæ." Phil. Trans., 1887, p. 458.

order which apparently progressed independently in different phyla, through a series of sub-tritubercular stages until trituberculy [1] was attained.

The tritubercular molar consists essentially of three cusps, forming what may be called the primitive triangles, so disposed that the upper and lower molars alternate. This, when attained, formed a central stage from which the great majority of recent molar types have diverged by the addition, modification and reduction of cusps; we must except the Monotremes, the Edentates, and possibly the Cetaceans, although there is considerable evidence that the cetacean molars were once of the triconodont type.[2] Among extinct orders, the Multituberculata (*Plagiaulax*, *Tritylodon*, etc.) must also be excepted from this series and discussion.

The almost universal predominance of trituberculy in the early geological periods, is very significant of the uniformity of molar origin. Of twenty known Mesozoic genera,[3] all except three[4] show trituberculy in some of its stages. As to the Lower Eocene, eighty-two Puerco species, representing twenty-six genera and five orders (Creodonta, Tillodontia, Lemuroidea, Condylarthra, Amblypoda), only four species have quadritubercular teeth, all the remainder are tritubercular.[5] Prof. Rütimeyer has recently pointed out the predominance of this type in the nearly parallel Egerkingen beds The contemporary Cernaysien fauna in the collection of Dr. Lemoine at Rheims, recently examined by the writer, shows exclusively tritubercular molars or their derivatives. By the Middle Eocene the lines of divergence towards the existing types of molars were well advanced, but trituberculy persisted in the dentition of several orders, in which it is found to-day (Lemuroidea, Insectivora, Carnivora, and many Marsupialia).

[1] First employed by Rütimeyer, "Ueber Einige Bezi ehungen zwischen den Säugethierstämmen Alter und Neuer Welt." Abh. d. schweiz. pal. gesellsch., Vol. XV., 1888, p. 54.

[2] See Brandt, "Die Fossilen u. Subfoss. Cetacean Europas." Taf. XXXII., figs. 4-9.

[3] The list given by the writer (op. cit., p. 247) is found to contain several synonyms. See "Additional observations upon the Structure and Classification of the Mesozoic Mammalia." Proc. Phila. Acad., Nov., 1888, p. 292

[4] Dicrocynodon (Diplocynodon), Docodon, Enneodon, Marsh.

[5] Cope, "Synopsis of the Vertebrate Fauna of the Puerco Series," Am. Phil. Soc., 1888. p. 298.

It follows that it is quite as essential for the comparative anatomist to thoroughly grasp the meaning and history of each of the component cusps of the tritubercular molar and of their derivatives, as it is to perfectly understand the elements of the manus and pes. For, the homologies of the cusps can now be determined almost as certainly as those of the digits. Take a human molar, for example, every component tubercle has its pedigree, and it can be demonstrated, almost beyond a doubt, which of these tubercles is homologous with the single reptilian cone. The writer recently (op. cit., p. 242) proposed the adoption of a distinct nomenclature for the different cusps of the tritubercular molar, and offered a series of terms for the primary cusps based as far as possible upon the primitive position and order of development, and in most instances in accord with their secondary position. This nomenclature can be extended to the secondary cusps in the sextubercular superior, and quinquetubercular inferior molars. The terms now in general use are based, for the most part, upon the secondary or acquired position, and in no instance upon the homologies of the cusps in the upper and lower molars, or even in corresponding molars of different genera, thus involving much confusion. For example, the Antero-internal cusp of the lower molar of *Mioclænus* is not homologous with the antero-internal cusp of *Hyopsodus*, nor with the antero-internal cusps of the upper molar of either genus.

The present contribution is based principally upon the writer's studies among the Mesozoic Mammalia, and, with some additions, upon Prof. Cope's numerous essays upon the tritubercular type in the Tertiary Mammalia.[1]

Four propositions may be laid down for discussion:—

(1.) That trituberculy was acquired during the Mesozoic period, in a series of stages beginning with the single cone and attaining to the primitive sectorial type in the Jurassic period.

[1] Professor Cope's essays abound with discussions and notes upon the origin and succession of the tritubercular type. (See collection, in "Origin of the Fittest"). He has outlined the transition from the single cone to the tritubercular crown (p. 347); the tubercular sectorial (p. 246); the quadritubercular type (p. 245 and p. 359); the *Spalacotherium* molars as a transition to the *tritubercular* (p. 259). The acquisition of the superior and inferior quadritubercular molar (p. 361). The prediction of the discovery of Carnivora with triconodont molars (p. 365), and of the simple tritubercular type in both jaws (p. 362).

(2.) The majority of Mesozoic mammals showed trituberculy in some of its stages. Present evidence goes to show that the remaining, or aberrant types, if such existed, did not persist. The majority of the persisting forms of later periods were derived from the forms, with simple tritubercular molars, of earlier periods. It follows that trituberculy was an important factor in survival.

(3.) The definite homologies of the primary and to some degree of the secondary cusps in the upper and lower molars can be established.

(4.) The mode of succession of tooth forms favors the kinetogenesis theory advanced by Ryder and Coope.

There are three general observations to be made:—

First.—In attempting to complete the history of each of the cusps, we naturally find that the palæontological record is not sufficiently perfect to admit of our following a certain type along a single phylum back to the primitive type. We must at the outset proceed upon the principle of similar effects, similar causes. For example, since the history of the development of the intermediate tubercles in the superior molars of the Lemuroidea (Pseudolemuroidea, Schlosser) is perfectly clear during the Wasatch and Bridger epochs—it is safe to infer that the intermediate tubercles of the Ungulate molars, which are fully developed in the underlying Puerco, had the same history. *Second.*—There are in each period *Aberrant types* which embrace either incomplete or degenerate tritubercular stages, *i.e.*, a high specialization in which the past record is obliterated, or, finally, stages in non-tritubercular lines of development. *Third.*—In the parallel evolution of trituberculy in different phyla we find that the progression is by no means uniform. In every geological period in which the fauna is well known we observe *progressive* genera which outstrip the others in reaching a certain stage of molar development, contrasted with *persistent* types which represent arrested lower stages of development, while between them are the *central* types which represent the degree of evolution attained by the majority of genera. The latter may be said to constitute the stage which is characteristic of the period.

The Stages of trituberculy may now be defined as seen in different types in their order of succession:—

I. *Haplodont* Type (Cope).[1] A simple conical crown. The fang usually single and not distinguished from the crown. This type has not as yet been discovered among the primitive Mammalia.

A *Protodont* Tub. Type.[2] The crown with one main cone, and lateral accessory Cuspules; the fang grooved. There is some question as to the advantage of distinguishing this as a type, for it stands intermediate between types I. and III. Example, *Dromotherium* of the American Triassic.

II. *Triconodont* Type (Osborn, op. cit., p. 242). The crown elongate, trifid, with one central cone and two distinct lateral cones The fang double. Example, *Triconodon.*

III. *Tritubercular* (Cope)[3]. The crown triangular, surmounted by three main cusps, the central cone placed internally in the upper mollars and externally in the lower molars. Example, the lower molars of *Spalacotherium* and *Asthenodon.* This type is rare in its primitive condition as above defined.

The upper and lower molars are alike in types I. and II.; in type III. they have a similar pattern but with the arrangement of the homologous cusps reversed. These types are all primitive. In the following sub types, the primitive triangle forms the main portion of the crown, to which other "secondary" cusps are added, the homologies of which in the upper and lower molars are somewhat doubtful. Parallel and with an intimate relation to the addition of the secondary cusps, is the division of the tritubercular into a secodont and bunodont series, according to the assumtion of a purely cutting or crushing function. In departing from the primitive type, the upper and lower molars diverge in structure, and the homologies of the secondary cusps in each are somewhat doubtful.

LOWER MOLARS.

A. *Tubercular Sectorial,* sub type (Cope). *a.* The primitive

[1] "The Homologies and Origin of the Types of Molar Teeth in the Mammalia Educabilia." Journ. Phila. Acad., 1874. The term *Homodont* was previously applied to this type by Rütimeyer, "Odontographie der Hufthiere, etc." Verh. d. Naturforsch. Gesellsch. in Basel, Band. III., 1863, p. 563. In the writer's opinion this term has acquired a special significance as applied to a whole series of teeth, viz., the reverse of "heterodont," and may well be retained in this sense.

[2] Osborn, op. cit., p. 222.

triangle elevated and its cusps connected by cutting crests; a low posterior heel. *b.* This type embraces a *quinquetubercular* form in which the heel consists of two cusps, an internal and external.[1] *c.* In the Bunodont series it develops into the *quadritubercular* form, by the loss of one of the primitive cusps.

UPPER MOLARS.

B. *Tritubercular. a.* The primitive triangle in the secodont series purely tricupsid. *b.* This embraces a *quinquetubercular* form in which "intermediate" tubercles are developed, both in the Secodont and Bunodont series. *c.* In the Bunodont series a postero-internal cusp is added, forming the *sextubercular* molar.

NOMENCLATURE OF THE CUSPS—As above stated, there is no doubt about the homologies of the three "primary" cusps (protocone, paracone, metacone) in the upper and lower molars They may be given the same terms, with the arbitrary suffix *id*, to distinguish the lower cusps. The first "secondary" cusps (hypocone-hypoconid), added to the upper and lower molars of the primitive triangle, modify the crown from a triangular to a quadrangular shape, and hence may be considered homologous. The three additional secondary cusps (protoconule, metaconule, entoconid) evidently have no homology with each other.

TERMS NOW IN USE.	PROPOSED TERMS.[2]	ABBREV.
Upper Molars.		
Antero-internal cusp	Protocone.	pr.
Postero- " " or 6th cusp	Hypocone.	h.
Antero-external "	Paracone.	p.
Postero- " "	Metacone.	m.
Anterior Intermediate cusp	Protoconule.	pl.
Posterior " "	Metaconule.	ml.
Lower Molars.		
Antero-external cusp	Protoconid.	pr.
Hostero- " "	Hypoconid.	h.
Antero-internal cusp, or 5th cusp	Parrconid.	p.
Intermediate or antero-internal cusp (in quadritubercular molars)	Metaconid.	m.
Postero-internal cusp	Eutoconid.	e.

Evolution of the Cusps. The cusp evolution in the Mesozoic period has been fully discussed by the writer (op. cit., pp.240-4)

[1] American Naturalist, April, 1883, p. 407.

[2] I am much indebted to my colleagues Professors Macloskie and Winans for tie assistance in the selection of these terms.

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PLATE XXV.

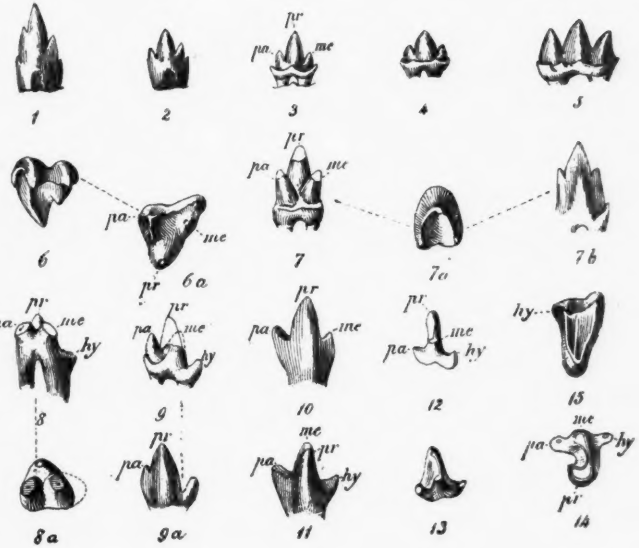


FIG. 1.

FIG. 2.

FIG. 1.—Molar teeth of Mesozoic Mammalia.
FIG. 2.—Molars of opposite jaws in normal mutual relation.

and in the Tertiary period, by Professor Cope, so that only a brief résumé is necessary here. In *Dromotherium* (fig. 1), from the upper Triassic, the oldest mammalian type known, with the exception

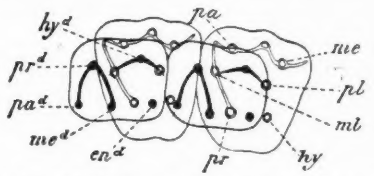


FIG. 1.—Diagram of quadritubercular molars of both jaws in normal mutual relation; the superior cusps double lines; the inferior black.

of *Microlestes*, the molars have a main protoconid with several minute lateral cuspules, differing in size in the different teeth, but in general giving a trifid appearance to the crown. The molars of the contemporary *Microconodon* (fig. 2) also have unpaired fangs, but distinctly trifid crowns, with the anterior and the posterior cusps, or para and metaconids, upon the slopes of the protoconid. This Triconodont type reappears, with the addition of a cingulum and paired fangs, in *Amphilestes* (fig. 3) and *Phascolotherium* (fig. 4) of the lower Jurassic and persists in *Tricondon* (fig. 5) of the upper Jurassic. In this succession we observe especially the relative subsidence of the protoconid and upgrowth of the para- and metaconids. Contemporary with *Amphilestes* is the classical genus *Amphitherium* (fig. 6). A recent examination of the type specimen by the writer revealed the very interesting fact that the molars of this genus are probably of the primitive tubercular-sectorial types,—the oldest known example. Only the paracone and metaconids and hypoconids have been observed heretofore, but one can see the tip of the main external cusps between the former pair. This pattern is repeated, with a considerable elevation of the heel, in *Peramus* of the upper Jurassic.[1] Neither of the two foregoing are of the primitive heelless tritubercular type which is apparently found in *Spalacotherium* also upper Jurassic, and in the nearly related if not synonymous *Peralestes*, Plate XXV. Contemporary with the above, are numerous genera of the *Stylodon* order; among these, *Asthenodon* is of

[1] This genus includes also *Septocladus dubius* Owen, and *Spalacotherium minus* Owen. See Proc. Phila. Acad., Nov. 1888, p. 292.

the primitive tritubercular type without the hypoconid, all the remainder present various modifications of the tubercular sectorial.

This covers our knowledge of trituberculy in the Mesozoic period. No bnunodont forms are known—they were probably developed during the Cretaceous, for a few are found well developed in the Puerco. In the Sectorial series many of the types do not widely depart from those seen in the Jurassic, but the Bunodont series are universally characterized by the initial or advanced development of the proto- and metaconules in the upper molars and the apperance of the *Entoconid* upon the inner side of the hypoconid below.

The principles governing cusp development.—It is remarkable to note in how many particulars the actual succession of molar development in the Mesozoic period coincides with the theoretical scheme of origin of trituberculy proposed by Cope[1] and supported by Wortman[2] several years ago. At that time *Spalacotherium* and the genera now embraced under the *Triconodontidæ* were the only Mesozoic mammals whose molar structure was fully known, and the views of these authors were partly speculative and partly deductive from recent dental anatomy.

Two hypotheses may be advanced to explain the evolution of the ritubercular type. The first is that the type has been acquired by the selection of accidental variations in the production of new cusps and modelling of old ones. The second is, that the interaction of the upper and lower molars in the movements of the jaws has resulted in local increase of growth at certain points, resulting first in new cusps, then in a change of position and of form in the cusps. Both hypotheses are open to numerous objections and are by no means mutually exclusive, but the whole subject is so complicated as to require a separate treatment. The balance of evidence in tritubercular evolution seems to favor the second or kinetogenesis theory—as apparently witnessed in two laws of cusp development.

I. The primary cusps first appear as cuspules, or minute cones,

[1] "The Evolution of the Vertebrata Progressive and Retrogressive," American Naturalist, April, 1885, p. 350.

[2] "The Comparative Anatomy of the Teeth of the Vertebrata," 1886 p. 418.

at the first points of contact between the upper and lower molars in the vertical motions of the jaws.

II. The modelling of the cusps into new forms, and the acquisition of secondary position, is a concomitant of interference in the horizontal motions of the jaws.

The second law applies especially to the evolution of the molars after the acquisition of the trituberculer stage, and has been ably proposed and supported by Ryder,[1] principally in its application to recent types of teeth. The first, although not heretofore distinctly formulated, is partly founded upon facts and principles advanced by Cope, and applies chiefly to the stages which have been discussed in this essay.

During the Homodont mammalian or sub-mammalian molar stage, the jaws were probably isognathous and the simple cones alternated as in the *Delphinidæ* (fig. 1). The first additions to the protocone appeared upon its anterior and posterior surfaces. The growth of the para- and metaconids involved anisognathism,[2] for we find in the later triconodonts that the lower molars closed inside of the upper (*Triconodon*, fig. 2). There are several transition forms such as *Tinodon* and *Menacodon* between the primitive triconodont type and *Spalacotherium*, and it has been assumed by Cope and the writer (op. cit., p. 243) that the para- and metaconids were first formed upon the anterior and posterior slopes of the protoconid and then rotated inwards, but it is also possible that they were originally formed upon the inner slopes. In the complemental formation of the upper and lower triangles the jaws remained nearly isognathous (fig. 4). There is no evidence as to the origin of the hypoconid, which as a rule preceded the hypocone, as it was developed very early. In the *Stylacodontidæ*, *Phascolestes*, *Amblo-*

[1] "On the Mechanical Genesis of Tooth Forms." Proc. Phila. Acad., 1878, p. 45.

[2] As employed by Ryder (op. cit., p. 45). "So as not only to indicate respectively parity and disparity in transverse diameter of the crowns of the upper and lower molars, but also the parity or disparity in width transversely, from outside to outside," etc.

It is clear that in the homodont condition, with the teeth simply piercing the food, the greatest comminution (of the food) is effected by isognathism; in the triconodont stage, the jaws must be anisognathous to close upon each other, but the tritubercular stage admits a return to isognathism by the alternation of the triangles.

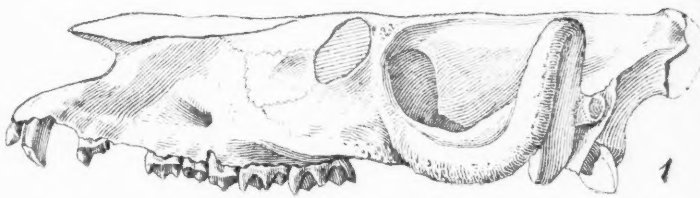
therium, etc., the crowns rapidly increased in transverse diameter (fig. 7) and, in some genera, they (Kurtodon) so far lost the tritubercular aspect that, but for the connecting form *Asthenodon* (fig. 6), we might hesitate to place them in this series. The key to the further evolution of the crown is seen in the bunodont series during the lower Eocene period.

The superposition of the lower and upper molar patterns brings out many interesting facts. First, even in the complex crowns of the bunodont molars the primitive triangles retain their primitive alternating arrangement. Second, the jaws are somewhat anisognathous. Third, in support of the first law of cusp development, we observe that the protoconule and metaconule are developed at the points of contact with the ridges which extend from the hypoconid, and, secondly, that the hypocone appears at the point where the paraconid abuts against the protocone. It follows from a comparison of numerous species of *Pelycodus* and *Mioclœnus* that as the hypocone develops, the paraconid recedes, as first observed by Cope; a fact difficult to reconcile with the kinetogenesis theory. In this manner the inferior primitive triangle is broken, as the upper molars develop into the sextubercular and the lower into the quadritubercular type. The complemental development of the upper and lower molars in the known genera of successive horizons is approximately displayed in the subjoined table.

The Eocene list of genera will be greatly reduced, especially in the Tritub.-tuberc-.sectorial type, when the upper and lower jaws are found associated, and it must be clearly understood that the sub-types a, b, c, in the above table, are very closely related by transition forms. In fact, in the carnivorous forms, the extreme secodont and bunodont types are frequently seen side by side, as in the first and second inferior molars of *Didymictis*. The chief distinction between these two series is the greater development of the secondary cusps and the almost invariable loss of the paraconid in the latter; this is effected by the broader surfaces of contact in the bunodont crowns. In the secodont series, on the other hand, the development of the secondary cusps is subordinated, and the metaconid is almost invariably suppressed.[1]

[1] See Cope: "Origin of the specialized Teeth of the Carnivora." Am. Naturalist, March, 1879.

PLATE XXVI.



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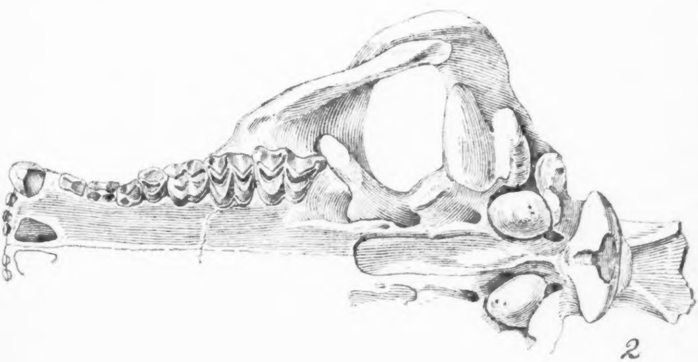

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FIG. 1.—*Merycochœrus macrostegus* Cope.

FIG. 2.—*Merycochœrus superbus* Leidy.

	Secodont Series.			Bunodont Series.					
	I. A.	II.	III.	a.	a. c.	b.	c.		
Molars, Upper		Tricono-dont.	Trituber-cular.	Trituber-cular.	Trituber-cular.	Quinque-tuberc.	Sextuber-cular.	Aberrant.	Lopho-dont.
Molars, Lower	Protodont	Tricono-dont.	Trituber-cular.	Tuberc. Sectorial.	Quadritu-bercular.	Quinque-tuberc.	Quadritu-bercular.		Symbo-rodont.
Middle Eocene,* Bridger				22	4	7	9	1	11
Lower Eocene,** Puerco				6	2	2	1		
Upper Jurassic***		3	2	5				4	
Lower Jurassic		3		1					
Triassic	1	1							

* From Prof. Marsh's list of Bridger genera, excluding the Rodentia (see various papers). The Insectivora and Creodonta belong to sub-type a; the Lemuroidea, to sub-types b and c.

** From Prof. Cope's list of Puerco genera (see "Synopsis, etc.").

*** From Author's list of Mesozoic genera (see op. cit., p. 247).

Adapis and *Anaptomorphus* are examples of Sub-types a, c, associated; for it frequently happens that the paraconid atrophies without a complete enlargement of the hypocone. A study of the diagram demonstrates, however, that the association of Sub-types b and c is impossible. The recent monkeys *Tarsius* and *Loris* afford a good illustration of the association of tritubercular, quinquetubercular, sextubercular and quadritubercular molars.

The subsequent evolution of the molars, in different orders, was characterized, first, by the loss of the primary cusps, *e.g.*, the metaconid in the Carnivora,[1] the paraconid in the Ungulata. Second, by the loss of some of the secondary cusps, *e.g.*, the proto- and metaconules in the Artiodactyla.[1] Third, by the metamorphosis in the form of the cusps. This subject has been fully

[1] Schlosser: "Beitrage zur Kenntniss der Stammgeschichte der Hufthiere," Morph. Jahrb., 1886, p. 123, has especially drawn attention to the probability that the Artiodactyla were derived from sexitubercular forms.

treated by Rütimeyer, Kowalevsky, Cope, Schlosser and others.

The Relation of Trituberculy to the Persistence of Mammalian Phyla.—The above table shows somewhat indefinitely, but none the less positively, the general progression of the Mammalia, to and from the primitive tritubercular type. As already stated, even with our present very limited knowledge, certain stages appear to have been characteristic of certain periods, as follows: the triconodont in the lower Jurassic; the primitive tritubercular and tubercular sectorial in the upper Jurassic; the secodont and bunodont subtypes of trituberculy, predominated in the Puerco; in the Bridger, the Perissodactyl ungulates had mostly passed beyond into the lophodont and symborodont types, and the Artiodactyls were approximately in the stage of sub-types c; but the Lemuroidea, Creodonta, Insectivora, etc., were, almost without exception, tritubercular.

There can be little doubt that, parallel with the tritubercular forms, in each period, there were aberrant or degenerate types, but it is difficult to determine which these are. Many Mesozoic types, which the writer formerly considered aberrant, have now proven to be tritubercular.[3] The upper Jurassic genera included under the *Dicrocynodontidæ* (see Marsh, *Amer. Journ. Sc.*, April, 1887, p. 338) are apparently aberrant. There are several degenerate types among the Puerco and Wasatch Creodonts, such as *Dissacus* and *Mesonyx.* But there is a striking proof of the superiority of the tritubercular molar in the fact that, according to our present knowledge at least, the Jurassic mammals possessing aberrant or degenerate molar types did not persist into the Puerco, nor did such types in the Puerco persist into the Bridger. There is some doubt as to the persistence of the sub-tritubercular stage; the writer previously considered the *Thylacinus* molars as triconodont; but Mr. Lydekker has called attention to the probability that the metaconid has disappeared and been replaced by a heel as in the sectorial teeth of the Carnivora. The disappearance of the degenerate types may be attributed to the general principle that rapid specialization and loss of parts leads ultimately to extinction, by depriving the animal of the means of adaptation to new conditions, or surroundings.

[3] See "Additional Observations upon the Structure and Classification of the Mesozoic Mammalia." Proc. Phila. Acad., Nov., 1888.

The mechanical superiority of the tritubercular type, over every other has been repeatedly demonstrated in its plastic capacity of adaptation to the most extreme trenchant and crushing functions.

THE ARTIODACTYLA.[1]

BY E. D. COPE.

THE Artiodactyla is the suborder of the Diplarthrous Ungulata in which the astragalus articulates with the second row of tarsal bones by a ginglymus or hinge, and in which the third and fourth toes are equally or subequally developed.[2] It includes the most highly modified of the Mammalia, whether we regard the organs of locomotion or of digestion. The antelope and deer illustrate the greatest speed to which the mammal has attained. Their extraordinary apparatus for the digestion of vegetable substances which contain but a small percentage of nutritious proteids, has given them an extraordinary advantage, so that they are after the rodents, the most abundant of their class, in spite of the persistent persecution of the carnivorous species. They attain in the genera Giraffa and Bos the largest dimensions in the class, excepting only the Proboscidia.

The Artiodactyla make their first appearance in the early or Wasatch Eocene in the genus Pantolestes Cope. A genus exists at a corresponding horizon in Europe. No other genus of the suborder appears with it. Its representatives steadily increase in numbers in the succeeding Bridger and Uinta epochs in America, and in the Calcaire grossier and Gypse of Europe. Some of these, *e.g.*, the Anoplotheriidæ of Europe, diverge from the line of succession, while others, *e.g.*, Xiphodontidæ, are clearly ancestors of later forms. In America, the Pantolestidæ appear as ancestors of the Camels especially. I now give a synopsis of the families of the suborder and their phylogenetic relations.

I. Superior molars tritubercular (Pantolestoïdea).

Molars bunodont; four digits............................*Pantolestidæ*.

[1] Modified for the Naturalist from a paper by the author in the Proceeds. of Amer. Philos. Society, 1887, p. 377.

[2] See Naturalist, November, 1877.

II. Superior molars quadritubercular with an intermediate fifth.

1. Three digits (Anoplotheroïdea).

Intermediate tubercle anterior........................... *Anoplotheriidæ.*

11. Two or four digits (Anthracotheroïdea).

A. The intermediate tubercle posterior.

Four digits; molars bunodont................................ *Dichobunidæ.*

Four digits; molars selenodont.............................. *Cænotheriidæ.*

AA. The intermediate tubercle anterior.

Four digits; one series of V's below............... *Anthracotheriidæ.*

Two or four digits; two series of V's below......... *Xiphodontidæ.*

III. Superior molars quadritubercular, without an intermediate fifth.

A. Molars bunodont, or cross-crested, (Suoïdea).

Mandibular condyle triangular; no postglenoid process...... *Suidæ.*

Mandibular condyle subcylindric; a postglenoid process... *Hippopotamidæ.*

AA. Molars selenodont (with four crescents above).

a. Inferior molars with one series of crescents (Merycopotamoïdea).

Premolars unlike molars .... *Merycopotamidæ.*

aa. Inferior molars with two series of crescents.

β. Superior premolars (except first premolar) with one crest (Cameloïdea).

γ. "Fourth premolar like molars below, with three crests above."

Two digits only (four? in Agriochœrus)............... *Dichodontidæ.*

γγ. Fourth premolar entirely different from molars.

δ. Navicular and cuboid bones distinct from each other.

ε. Superior incisors present.

No cannon bone; a vertebrarterial canal .... *Oreodontidæ.*

No vertebrarterial canal; no cannon bone .... *Poëbrotheriidæ.*

No vertebrarterial canal; a cannon bone;............ *Protolabididæ.*

εε. No superior incisors (except incisor three).

No vertebrarterial canal; a cannon bone; superior p. m. iv with external and internal crests .... *Camelidæ.*

Like Camelidæ, but superior p. m. iv a simple cone ... *Eschatiidæ.*

δδ. Navicular and cuboid bones coössified.

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PLATE XXVII.

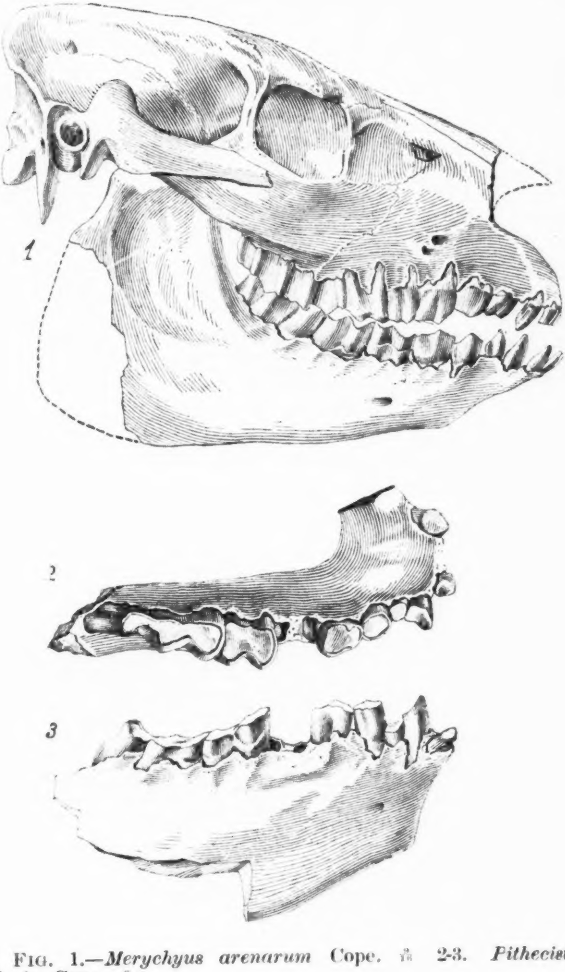


FIG. 1.—*Merychyus arenarum* Cope. $\frac{3}{8}$ 2-3. *Pithecistes facies* Cope. $\frac{3}{4}$

All premolars but No. iv without internal crescent ...... *Tragulidæ.*

$\beta\beta$. Superior premolars 2-3-4 with internal as well as external crest; a naviculocuboid bone; no superior incisors (Boöidea).

Superior p. m. ii without internal crescent.................................*Moschidæ.*
Superior p. m. ii with internal crescent.
Horns permanent, originating distinct from skull.........*Giraffidæ.*
Horns permanent, processes of the skull ....*Bovidæ.*
Horns periodically shed ....*Cervidæ.*

Of the preceding sixteen families, ten are extinct. The six families with living representatives are the Suidæ, the Tragulidæ, the Camelidæ, the Moschidæ, the Cervidæ, the Giraffidæ, and the Bovidæ.[1] Thus none of the primary divisions, I and II, have recent representatives. But few of them in fact (some Cænotheriidæ and Anthracotheriidæ) survived the Eocene epoch. Division III is, on the other hand, characteristic of Miocene and recent time, except that some specimens of Gelocus of the Tragulidæ have been found in Upper Eocene beds. Several genera of Tragulidæ, with Elotherium and Poëbrotherium and Oreodon, belong to Oligocene beds.

Tubercular or bunodont molars are of prior age to selenodont molars, phylogenetically speaking. Of the former, the tritubercular type, it has been already shown, is ancestral to the quadritubercular type. Pantolestidæ are then clearly ancestral to all known Artiodactyla, and are themselves probably the descendants of the lost Amblypoda Hyodonta, whose existence I have anticipated on hypothetical grounds. Of the remaining families which are constructed on the quadritubercular basis, there are two types, as represented in divisions II and III of the preceding table. The intermediate or fifth lobe is especially characteristic of Eocene Artiodactyla. The intermediate tubercles exist in the Pantolestidæ, and one of them is preserved in the families of division II; but in group *A* it is the posterior one, and in group *AA* it is the anterior one. In the Suidæ and Hippopotamidæ, which are permanently bunodont, the intermediates are either lost or so divided as to lose their distinctive

[1] Antilocapra is sometimes separated from the Bovidæ as the type of a family, because it is said to sometimes shed its horny horn-sheath. This character, were it really normal, has no significance sufficient for the establishment of a family division.

character. In Elotherium traces of both the intermediates are visible, but they are obscure. The genetic relations of the families with five lobes to those with four are supposed by Schlosser to be direct and ancestral. This looks probable in the case of the Merycopotamidæ of the latter group, which has inferior molars like those of Hyopotamus of the former group. Whether the remaining families of division III *AA* (see table) (four-lobed) came off from the families of division II (five-lobed) is uncertain. It is probable that the fifth and sixth (or intermediate) tubercles were present in all primitive Artiodactyla, but they may have been lost, as in the Suidæ, in the bunodont stage, which gave origin to III *AA*, so as to be wanting from the earliest four-lobed selenodont ancestors. Of the two types of II (Anthracotheroïdea) the division *A* is supposed by Schlosser to have been the ancestor of the true selenodonts (III *AA*), but excepting in the case of Merycopotamidæ, this has not yet been demonstrated. Scott suspects with reason that the quinquetubercular Protoreodon is the ancestor of the quadritubercular Oreodon.

Leaving this debatable question, I refer to the family of the Anoplotheriidæ. The remarkable structure of the feet discovered by Gervais, and shown by Schlosser to belong to this family distinguishes it at once from all families of this and all other orders.

FIG. 1.—Right posterior foot of *Anoplotherium latipes* Gerv. $\frac{1}{8}$ nat. size. *Cal.*, Calcaneum; *As.*, astragalus; *Cub.*, cuboid; *Cu.*, cuneiforms.—From the Eocene of Debruge; from Gaudry, Enchainment du Monde Animal.

The second digit is well developed in both feet, and stands inwards at a strong angle to the other toes. A rudimental fifth is present in the manus, but not in the pes. The latter is therefore tridactyle. The third and fourth digits are equal in the pes, but the third exceeds the fourth in the manus, giving an entirely perissodactyle character. Some didactyle forms have been placed in this family, but this is inadmissible on ordinary taxonomic principles. The divergent inner toe is supposed to have supported a web, useful in an aquatic life. As remarked by Schlosser, the origin of the Anoplotheridæ is entirely obscure as yet, the only ancestor yet known being the Pantolestidæ. It is probable that some unknown member of the Anthracotheroidea, which had bunodont teeth, may

form one of the missing links. Cebochœrus offers the proper type of dentition, and the number of toes (four, Schlosser) is also appropriate, but whether there are any structural obstacles to its being ancestral to the Anoplotheriidæ I do not know.

Anthracotheriidæ can be properly supposed to have descended from a type of Pantolestidæ with well-developed lateral toes, by the addition of the fourth tubercle, and the loss of the posterior intermediate; while the Dichobunidæ have had the same origin, the posterior intermediate cusp being preserved. The Xiphodontidæ may be supposed to have come off from the Anthracotheriidæ by the usual process of diminishing the lateral digits and developing both sets of crescents in both superior and inferior molars. This family carried the specialization of the five tubercled type farther than any other.

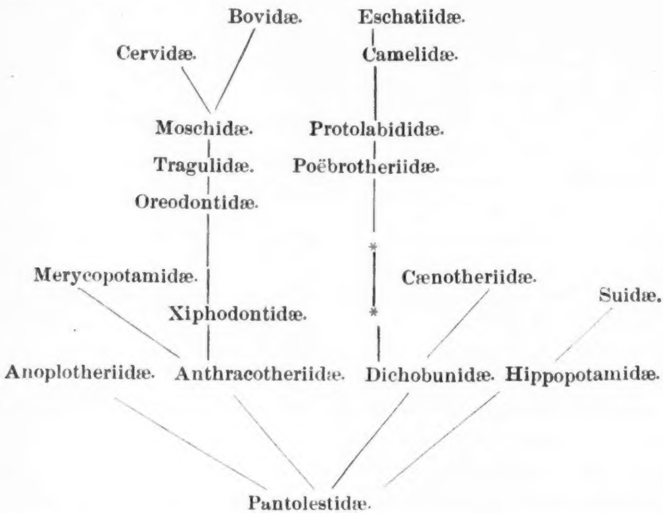
The Suoïdea have come off from the Pantolestoïdea by the addition of the fourth (posterior internal) tubercle to the superior molars. Some genus with better developed lateral (second and fifth) digits than Pantolestes must have been the ancestor. Such a form will be discovered. It has been already anticipated by Schlosser.[1]

It is a circumstance confirmatory of the view that the Cameloïdea and Booïdea are descendants of the Anthracotheroïdea rather than of the Suoïdea, that no genus of the latter superfamily shows the least tendency to assume a selenodont structure of the molars. It is therefore not unlikely that the two groups named may have had the history of the Merycopotamoïdea already referred to. They did not probably come from the Merycopotamoïdea themselves, since the geological age of the latter is too late. Of course, however, members of this group may be yet discovered in earlier formations.

The problems of the phylogeny of the remaining groups are less difficult, and have been largely solved by the investigations of Kowalevsky and Schlosser. Tragulidæ have been derived from Oreodontidæ with simpler premolar teeth than the typical forms, (*e.g.*, Dorcatherium and Lophiomeryx). In turn they have given origin to primitive Bovidæ (Cosoryx) through Gelocus, which have then branched off into specialized Bovidæ on the one hand, and

[1] Morphologisches Jahrbuch, 1886, p. 77.

Cervidæ on the other. The Poëbrotheriidæ have originated, from some family with diminished lateral digits, perhaps the Dichobunidæ, various intermediate genera being yet unknown. They are the direct ancestors of the Protolabididæ, the camels, and the Eschatiidæ. These relations may be expressed in the following table :—



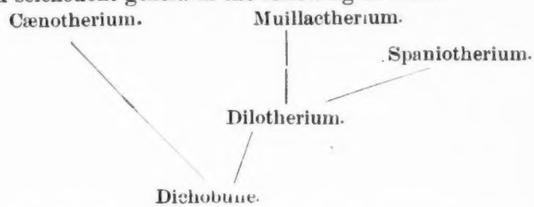
Of PANTOLESTIDÆ but one genus is known. The premolars are all simple in the upper jaw, except the fourth, which has one external and one internal tubercle. Six species are known from the Bridger and Wasatch Eocines of N. America. (FIG. 2.)

The structure of the premolars in Anoplotherium is complex for so primitive a type, and the third superior has an internal crest as well developed as in some of the Booïdæ. To the ANOPLOTHERIIDÆ are referred, besides Anoplotherium, Diplobune of Fraas and Dacrytherium, Mixtotherium and Mixochœrus of Filhol. But the structure of the feet of the latter genera is unknown. In Mixtotherium the fourth premolar is more, and the others less complex than in Anoplotherium. (FIGS. 1, 3.)

The known genera of DICHOBUNIDÆ are Dichobune of Cuvier, with Spaniotherium and Dilotherium of Filhol, in which the inter-

mediate tubercles are less developed than in Dichobune. They are related to the twe selenodont genera of CÆNOTHERIIDÆ, Cænotherium and Muillactherium. The latter differs from the former in the absence of the intermediate crescent from the last superior molars. The species of Cænotherium differ in the absence or presence of a short diastema in the dental series, and in its position in the lower jaw, whether behind the first or secondpremolar. (FIG. 4.)

The Dichobunid bunodont genera are ancestral to the Cænotheriid selenodont genera in the following fashion :—



This family terminated with the selenodont genera, which, as Schlosser remarks, left no known descendants.

THE ANTHRACOTHERIIDÆ present but few varations. Four genera are known, which differ as follows :—

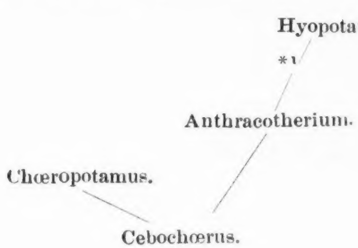
Entirely bunodont; no diastemata; canines developed. *Cebochœrus* Gerv.

Cusps of superior molars little flattened; diastemata; canine large. *Chœropotamus* Cuv.

Cusps of superior molars flattened; no diastemata; canines large. *Anthracotherium* Cuv.

Cusps of superior molars crescentoid in section; diastemata; canines large in males.............................. *Hyopotamus* Owen.

The three genera last named cannot, as Schlosser remarks, be related in direct lines, but through common ancestors; as may be shown thus :—



All the known species of this family are Old World excepting the single *Hyopotamus americanus* of Leidy. The genera Cebochærus and Chœropotamus are from the Eocene, while the remaining two genera are of Miocene age. Some of the Anthracotheriums equaled the Rhinoceros in size, and were powerful beasts, well armed with formidable canine teeth. The species of Hyopotamus were on the other hand, of inoffensive character and had narrow compressed muzzles like the lamas, but more generally elongate.

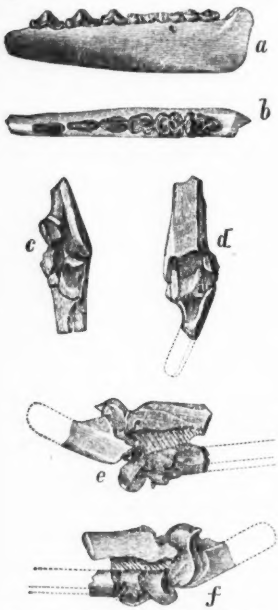


FIG. 2. — *Pantolestes brachystomus* Cope. Nat. size. From the Wasatch Eocene of Wyoming, N. A. Figs. *a*, *b*, mandibular ramus with teeth; *c*. *f*. tarsus, and parts of tibia and metatarsus.

The ancestral genus is bunodont, without diastemata, and with well-developed canines. The hypothetical genus (1) is selenodont, with short diastema, and well-developed canines.

The certainly known genera of the XIPHODONTIDÆ are four, which differ as follows:—

Molars bunodont; diastemata; canines large......*Rhagatherium* Pict.

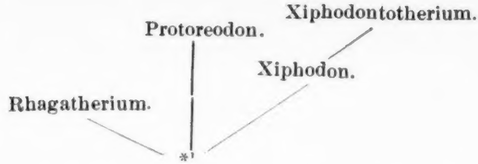
Molars selenodont; diastemata; canines medium........................ *Xiphodontotherium* Filh.

Molars selenodont; no diastemata; canines not distinct in form......... *Xiphodon* Cuv.

Molars selenodont; no diastemata; superior canine developed; inferior p. m. 4 functioning as canine. *Protoreodon* S. and O.

Cryptomeryx Schl. probably belongs here.

The relations of these genera are clearly somewhat like those of the preceding family. The bunodont condition of the molars of Rhagatherium is primitive, while its diastemata are the reverse: The continuous dental series of Xiphodon is primitive, while the detailed structure of the molars is advanced. These relations may be thus shown:—



The hypothetical genus 1 is simply a bunodont without diastemata, and with well-developed canines.

The genera of this family are Old World, except Protoreodon, which is North American. The *Xiphodon gracilis* Cuv. is one of the most abundant species of the Gypse of Paris and its equivalents. The restoration of Cuvier shows it to have been a graceful animal, with slender legs and neck. In Prootreodon S. and O. we first see the enlargement of the fourth inferior premolar (first olim) to function as a canine, which afterwards became such an important character of the Oreodontidæ. Probably two species are known, both from the Uinta formation of Utah; the type, *P. pavous* Scott and Osborn, being about the size of a raccoon.

FIG. 3.—*Anoplotherium caylusense.* Lyd part of right maxilla with molars, from Upper Eocene of Claylux France. Nat. size. From Lydekker.

The Hippopotamidæ embraces a considerable variety of genera, which are spmetimes arranged in separate families. They are as follows:—

I. Digits four.

A. Metapodials distinct, distally keeled behind only; inferior incisors straight, subcylindric (Hippopotaminæ).

Six lower incisors; orbit closed............*Hexaprotodon* Caut. Falc.
Four lower incisors; orbit closed...............*Hippopotamus* Linn.
Two lower incisors; orbit not closed.................*Chœropsis* Leidy.

AA. Metapodials distinct; inferior incisors normal (Hyotheriinæ).

Canines small, the inferior not received into a notch of the upper jaw; premolars $\frac{4}{4}$; fourth with two external tubercles;
Hyotherium von. M.

Canines large, the inferior received into a deep excavation in front of the superior canine ; premolars $\frac{4}{4}$; fourth with one lubercle ; *Bothrolabis* Cope.

Like Bothrolabis, but premolars $\frac{3}{3}$.......... .... *Chœnohyus* Cope

II. Digits three.

I. Metapodials fused proximally (Dicotylinæ).

a. Premolars like molars ; a deep notch in front of superior canine.

Premolars $\frac{3}{3}$; cusps of molars separate.................. *Dicotyles* Cuv.

Premolars $\frac{3}{3}$; cusps of molars united into partial cross-crests *Platygonus* Lec.

III. Digits two (Elotheriinæ).

Superior canines decurved ; last inferior molar without heel ; *Elotherium* Pom.

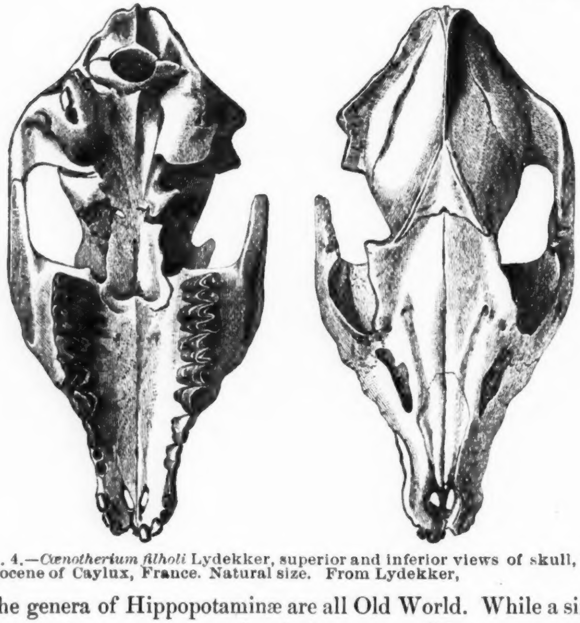


FIG. 4.—*Cœnotherium filholi* Lydekker, superior and inferior views of skull, from the Eocene of Caylux, France. Natural size. From Lydekker,

The genera of Hippopotaminæ are all Old World. While a single living species represents each of the genera Hippopotamus and Chœropsis, there are several extinct species of Hippopotamus and Hexaprotodon. These are chiefly confined to the Upper Miocene

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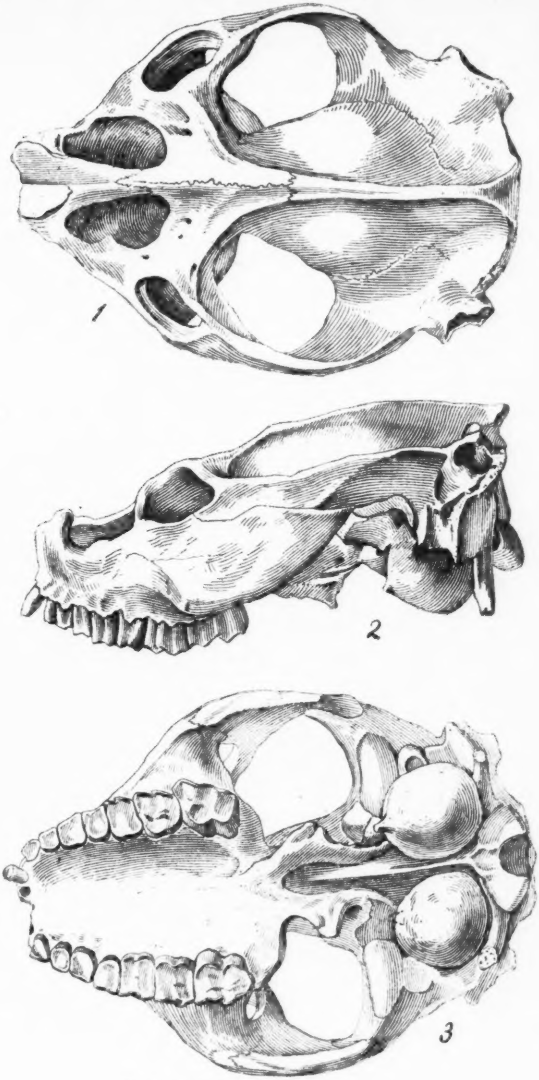
PLATE XXVIII.



Cyclopidius emydinus Cope.

of India, but a species has been found in Algerian deposits, and a large form, *Hippopotamus major*, is abundant in the Plistocene of Southern Europe. Of the Hyotheriinæ the most generalized form, Hyotherium, is represented by several species in Europe and India. In its characters it is the most primitive of the family excepting in the weakness of the canine teeth. It is nearer the ancestral genus of the family than any that is yet known. In Bothrolabis we have a distinct approach to Dicotyles, of which it is probably the ancestor. Four species from the John Day or Middle Miocene of Oregon are known. They were of the sizes of the existing peccaries. The genus Platygonus embraces extinct species of North America and Mexico. *P. vetus* Leidy has left remains in the Pennsylvania Bone Caves. It was larger than the white-lipped peccary. *P. alemani* Dugés has been found in Mexico.

Several extinct species of Dicotyles are known, from the North American Plistocene and ? Pliocene. One of them, *D. nasutus* Leidy, has a more elongate muzzle than any of the recent species.

The Elotheriinæ embrace the oldest known forms of the family, dating in geological time from the Lower Miocene or Oligocene, and terminating with the summit of the middle Miocene. But one genus is certainly referable here, the Elotherium of Pomel; but a second, Tetraconodon Falconer, may belong in the same group. As the feet of the latter are unknown, the affinities cannot be yet determined. It differs in the inferior dentition from Elotherium by the huge size of its premolar teeth. Elotherium is represented by species over the Northern Hemisphere. The *E. magnum* is the only one known from Europe. It was larger than the domestic hog. The *E. mortoni* Leidy of North America was about the size of that animal. Its remains are common in the beds of White River age. It was accompanied by a huge species, the *E. ramosum* Cope, which has a skull as large as the Indian Rhinoceros. In all the species of this genus the mandibular ramus has two osseous projections, one opposite the symphysis, and the other well behind it. These are represented by wattles in old males of the recent hog. In the *E. ramosum* these tuberosities become processes, and the anterior ones especially are so long that when the chin was stretched, hog-like on the mud, it was raised well above the surface, allowing the passage underneath of water or of small animals. In the John

Day beds of Oregon another species of this genus is found, the *E. imperator* of Leidy, which was little inferior in dimensions to the *E. ramosum.* The greater part of its skeleton is known.

The pigs (SUIDÆ) are modified and specialized descendants of some form allied to Palæochœrus. Chronologically speaking they are of rather modern origin. The genera are as follows: —

(*a*) Molars and superior incisors not reduced; the former not covered with cement; superior canines recurved (Suinæ).

Molars with cusps united into transverse crests, *Listriodon* Meyer.

Molars with four much plicate tubercles on each................. ....*Hippohyus* Cautl. Falc.

Molars with numerous irregular accessory lobes; premolars $\frac{4}{4}$ .... *Sus* Linn.

No accessory lobes; premolars $\frac{2}{2}$..................*Babirussa* Cuv.

(*aa*) Superior incisors reduced in number; molars reduced in number, and the valleys filled with cement (Phacochœrinæ).

Superior incisors one; premolars none; molars $\frac{2}{2}$, with numerous tubercles; superior canines recurved...............*Phacochœrus* Cuv.

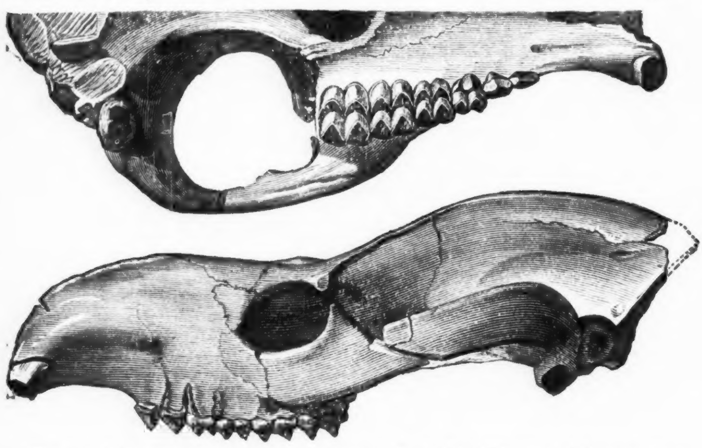
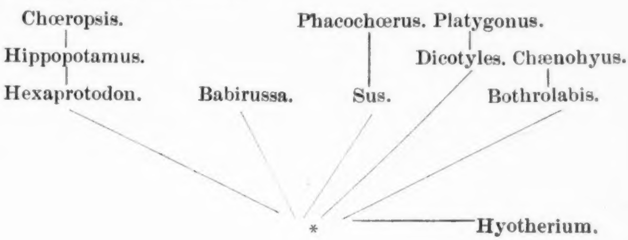


FIG. 5.—*Coloreodon ferox* Cope, skull from the John Day Miocene of Oregon, one-half natural size.

Listriodon and Hippohyus are the only genera of Suidæ which are extinct; but the extinct species of Sus are more numerous. In Listriodon the molar teeth are so tapir-like as to have led to its being placed in the Perissodactyla. When the skeleton was ob-

tained, it was found to be artiodactyle, as suspected by Kowalevsky. One species, *L. splendens*, has been found in the Middle Miocene of Western Europe. Hippohyus C. and F. is known from the Indian Siwaliks. A genus of probable affinities to it, founded on teeth only from Asiatic localities, is the Sanitherium of Schlagintweit. Some of the extinct species of Sus were of larger size than the existing hog, as the *S. giganteus* of the French Miocene, and the *S. erymanthius* of Pikermi, Greece. The *S. silvanius* Hodgson, a recent Indian species, is not larger than a small dog.

The phylogeny of these two bunodont families is nearly as follows, although the absence of intermediate types renders the final determination as yet impracticable. The main features may be however foreshadowed. The most generalized form is Palæochœrus, since its dentition is in all respects the most simple, while it preserves the full number of teeth. An unknown form resembling it, but with well-developed canine teeth, may have readily given origin to the Dicotyline line on the one side, and Sus and its immediate allies on the other. Babirussa is another derivative from the same centre. Phacochœrus may have come from some ally of Sus, since it carries to a great extreme the peculiarities of the latter genus. The ancestry of Hippopotamus is less easily determined. Its imperfect distal metapodial keels, which only exist on the posterior face of the condyle, bespeak for it an ancient ancestor. Its molar type is merely a complication of the quadritubercular, while the characters of its canines are an exaggeration of those of the primitive forms already mentioned. Several other genera, as Dicotyles and Sus, display the decumbent incisors which prepare the way for the remarkable straight digging incisors of Hippopotamus. The genus Hexaprotodon eases the passage backwards. These relations may be expressed as follows:—



The MERYCOPOTAMIDÆ embrace but one genus, Merycopotamus C. and F., which is a form of considerable interest. Its superior molars display the simple quadriselenodont type of the later families, but in the lower jaw the primitive condition of but one series of crescents still remains. Several species are known, all from the upper miocene of India.

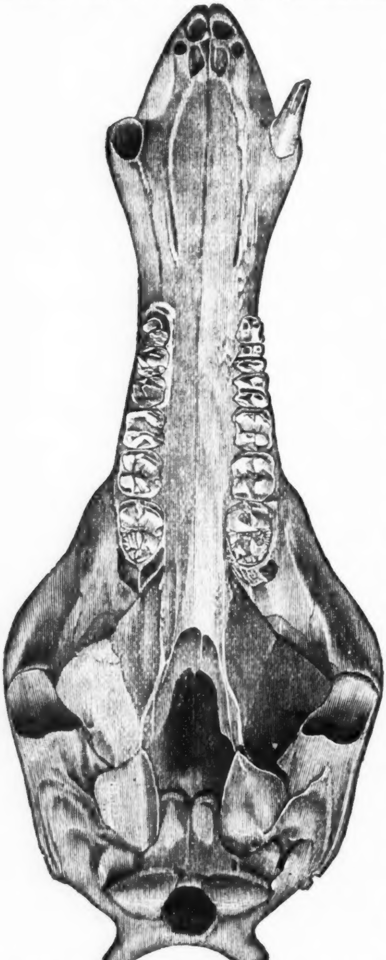


FIG. 6.—*Platygonus compressus* Leconte; skull from below, ⅜ nat. size. From Kentucky.

The OREODONTIDÆ is the prevalent type of Artiodactyla during Miocene time in North America. Their characters are as follows:—

Dentition: superior incisors present; molars selenodont. Cervicals with the transverse processes perforated by the vertebrarterial canal. No alisphenoid canal. Ulna and radius, and tibia and fibula distinct. Metapodial bones four on each foot, with incomplete distal trochlear keels. Lunar bone not supported by magnum Navicular and cuboid bones distinct.

The details of the structrue express various affinities. The axis is intermediate between that of the suilline and ruminant Artiodactyla; the other cervicals are suilline, while the remaining vertebræ are ruminant. The scapula is ruminant, not suilline; while the

humerus is like Anoplotherium. The radiocarpal articulation is intermediate between that of hogs and ruminants. The unciform supports the lunar bone. The sacrum is ruminant, the ilium suilline. The femur and tarsus are much like those of the peccary.

The known genera of this family are the following:—

A. Orbit complete; premolars four, the fourth with one external crescent. First premolar below functioning as canine.

a. No facial vacuities.

Premaxillaries distinct; otic bullæ not inflated; five digits in manus...*Oreodon* Leidy.

Premaxillaries distinct; otic bullæ inflated; four digits in manus..*Eucrotaphus* Leidy.

Premaxillaries coössified; otic bullæ inflated...*Merycochœrus* Leidy.

aa. Facial vacuities present.

Premaxillaries coössified, dentigerous; vacuities prelachrymal only...*Merychyus* Leidy.

Incisors six above, persistent; vacuities prelachrymal and prefrontal; nasal bones much reduced.....*Leptauchenia* Leidy.

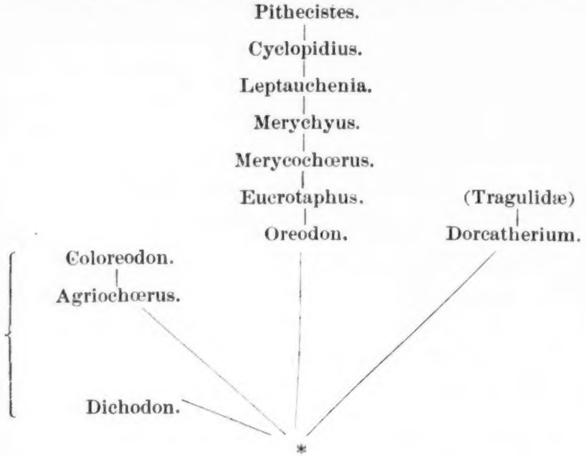
Incisors very few, caducous; vacuities as in Letanc phenia, very large...*Cyclopidius* Cope.

AA. Inferior premolars three. True inferior canine functional.

Inferior incisors one on each side...........*Pithecistes* Cope.

Starting from Oreodon as the ancestral form, Eucrotaphus follows at a little distance. The presence of the pollex observed by Scott in Oreodon proves that it must be referred to a five-toed common ancestor with Dorcatherium. The enlarged bullæ are added in Eucrotaphus, and the coössified premaxillaries in Merycochœrus and Merychyus. The latter commences the facial vacuities, which reach such huge proportions in Leptauchenia and Cyclopidius. The loss of the incisor teeth from both jaws, and diminished size, indicate that decadence is going on in Cyclopidius, but the last term is reached in Pithecistes. Here not only incisors but a premolar disappears. This family, once powerful in numbers, size and strength, disappeared with the Upper Miocene period in North America. These relations may be thus displayed. A common ancestor with Dorcatherium is assumed. This will be a genus like Protoreodon S. and O., but without the caniniform inferior p. m. i of

that genus, and probably with the fifth crescent of the superior molars. Agriochœrus may have been derived from the same.



The genealogical positions of these genera are as follows:

Oreodontinæ.	No. of Species	White River Epoch	John Day Epoch	Ticholeptus Epoch	Loup Fork Epoch
Oreodon Leidy	3	——			
Eucrotaphus Leidy	3	——	——		
Merycochœrus Leidy	8	——	——	——	——
Merychyus Leidy	6			——	——
Leptauchenia Leidy	3			——	
Cyclopidius Cope	2			——	
Pithecistes Cope	3			——	

The numbers of individuals of Oreodontidæ which must have existed during the Miocene period in North America is so great as to astonish the palæontologist. During the White River epoch droves of *Oreodon culbertsoni* inhabited the swamps, and the small *O. minor* was abundant. Several forms, perhaps species, coexisted with these two. During the John Day epoch Oregon and adjacent regions were overrun by the *Eucrotaphus pacificus*, and the large and formidable *Merycochoerus superbus* (Plate XXVI). At a still later date, in the Ticholeptus epoch, the species of Cyclopidius were scarcely less abundant. All of these forms were the prey of numerous Carnivora, mostly false sabre-tooth or half sabre-tooth cats,

of the family of the Nimravidæ. The large Merycochœri possessed the means of making a formidable defense, but the Merychyi of later age were of decidedly less vigorous mould (Plate XXVII). The species of Leptauchenia and Cyclopidius were probably aquatic in their habits. The species of the last named genus (Plate XXVIII.) had produced tympanic bones like the hippopotamus for the insertion of ears that projected above the water, while the eyes are partly vertical to permit of vision without much exposure of the head. The nostrils are at the extremity of a sharp muzzle like the snapping tortoise to premit of breathing without exposure of the face. The object of the remarkable facial vacuities in this genus and Leptauchenia is unknown. It may have permitted the attachment of an inflatable integument like the nasal hood of the hooded seal. In Pithecistes the incisor teeth have disappeared, and the short deep jaw, the only part which is known, resembles in its coössified symphysis, that of a monkey.

(To be continued.)

RECENT LITERATURE.

Davis's Text-book of Biology.[1]—Of this book of 462 pages a little more than one-third is devoted to plants, and hence properly to be noticed by the present reviewer. Unlike many works on biology, this is in fact two independent books printed and bound together. Each part has its separate bibliography and index-glossary, and there are no references from the one part to the other. One is puzzled, indeed, to see any good reason for calling the book one on biology: it is rather a botanical and a zoological book bound together.

Part I. takes up in succession Saccharomyces, Bacteria, Mucor and Penicillium as representing the fungi; Protococcus, Spirogyra, Fucus, Chara and Nitella, representing the Algæ; Funaria and Polytrichum for the Mosses; Pteris and Nephrodium (Aspidium) for the Ferns; Pinus for Gymnosperms, and a "typical Flowering plant" for the Angiosperms. Following these are short chapters on Comparative Vegetable Morphology and Physiology, and the Classification of Plants.

The book is not a laboratory manual at all, but rather a text-book to be read or studied. The author himself, in his preface, after referring to the several excellent works on practical biology which have appeared within the last few years, and the want of a comprehensive work on theoretical biology, says that "the object of the present text-book is, therefore, to supply such a systematic and simple exposition of the subject within small compass as, it is hoped, will be found helpful, both to those who are studying alone and to those who have the advantage of guidance in their work." Theoretical biology is, then, the scope of the work, and in this it stands in sharp contrast with Huxley and Martin's well-known laboratory handbook.

The treatment of Saccharomyces—the Yeast Plant—may illustrate the style of the book. First the Morphology is concisely discussed, giving the reader a good idea of the shape, size and structure of the plant, the latter including the cell-wall, protoplasm and vacuoles, with a doubtful reference to a nucleus. Secondly, the Physiology is taken up, and here nutrition is discussed in such

[1] *A Text-book of Biology:* comprising Vegetable and Animal Morphology and Physiology. Designed more especially to meet the requirements of the intermediate science and preliminary scientific examinations of the London University. By J. R. Ainsworth Davis, B.A., Trinity College, Cambridge; Lecturer on Biology in the University College of Wales, Aberystwyth. With numerous illustrations, "Glossary and Examination Questions." Philadelphia: P. Blakiston, Son & Co., 1012 Walnut street. 1888. [All rights reserved.]

a manner as to bring out the fact that the plant's food is a solution consisting essentially of carbon, hydrogen, oxygen, nitrogen, sulphur and phosphorus. Destructive metabolism, respiration, and reproduction follow, each including a brief summary of the principal facts.

In the main, the book appears to be brought up to our present knowledge, and, if one must use such a book at all, it may be recommended as giving in a condensed and systematic form the principal facts of Vegetable Morphology and Physiology. It remains to be said that, while the book bears the name of the American publisher on its title-page, both printing and binding were done by a London house, a new title-page alone having been pasted in to replace the original one.—*Charles E. Bessey.*

MICROSCOPICAL PHYSIOGRAPHY OF THE ROCK-MAKING MINERALS. By H. Rosenbusch. Translated by Joseph P. Iddings. New York: Wiley & Sons, 1888. Illustrated by 121 wood-cuts and 26 plates of photomicrographs. xiii. and 333 pp.—With the excellent translation of Prof. Rosenbusch's book, presented us by Mr. Iddings, there can no longer remain an excuse for the continued neglect of microscopical petrography by our colleges and advanced schools. Heretofore the immense mass of facts relating to the microscopical properties of minerals which have accumulated within the past ten or fifteen years, have been beyond the reach of those who are not familiar with the German language. The excellent compendium of Prof. Rosenbusch has not been available to English-speaking students on either side of the Atlantic. It is a matter for congratulation that the first translation of this book should have been made into English by an American Scientist, and by one who has proven himself so capable of undertaking the task as has Mr. Iddings.

The translation is at the same time an abridgement. The six hundred and sixty-four pages of the original have been reduced by the translator to three hundred and thirty-three. This has been accomplished by omitting the bibliography (which occupies eighty-eight pages in the original), by excluding the purely historical portions, and by restricting within narrow limits the discussion of the anomalous action of certain minerals in polarized light. Since these matters would be of little value to any but the advanced student in the subject, and since such a one must of necessity go to the original sources for his information, Mr. Iddings has done well in deciding not to confuse the mind of the beginner with too much of the unessential. So far as a hurried reading of the book allows one to judge, everything essential to the study of the optical properties of the rock-forming minerals has been retained, and in many cases additions have been made to the description of those minerals

which have been found to be much more widespread as constituents of rocks than was supposed when the German edition was published three years ago.

A further reduction in the size of the book is effected by a rather free translation, by which an entire sentence is sometimes reduced to the position of a short qualifying phrase, and by the omission of certain tables of refractive indices, but more especially by the exclusion of the references to the occurrences of the various minerals in rocks of foreign localities. To compensate for the latter loss, notes on American occurrences have been copiously inserted.

The style of the language used is clear; the expressions are forcible; and, better tnan all else, the reader of the translation may rest assured that he is getting the exact thought of the author of the original.

Not only is Mr. Iddings to be commended for his careful translation, but Messrs. Wiley & Sons are likewise to be congratulated on producing a work of such a pleasant appearance as the book before us.

The only fault that can be found with the volume is its price. It would seem that in view of the fact that the translation will meet with a ready sale in England and America, its price might have been placed at such a figure as to enable every one taking a course in geology to indulge in the luxury of a few weeks' work with the beautiful objects in rocks revealed to our eyes when aided by the polarizing microscope.—*W. S. B.*

GENERAL NOTES.

GEOGRAPHY AND TRAVEL.

Nansen's Greenland Expedition.—The last mail from Norway brings more information about the Nansen expedition to the interior of Greenland. The expedition consisted of the following named daring men, under the leadership of Dr. Frithjof Nansen, conservator of the Bergen Museum; Lieut. Olaf Dietrichsen, Mate Otto Sverdrup, Christian C. Trana, Ole N. Ravna, and Samuel J. Batto, all especially selected men, strong and healthy in body and mind and good "ski-runners." "Ski" are the snow shoes extensively used in Norway for travelling over the snow fields of that country. The party left Norway on May 2; travelled by steamer as far as to Iceland, where they arrived in the middle of June. From Iceland the whaler Jason brought them over to Greenland, and on the

17th of July left them on the drifting ice with the land in sight some few miles distant. From that time until they could reach the inhabited west coast of Greenland communication with the rest of the living world would be an absolute impossibility. A stretch of 450 miles, never traversed by man, lay before them; they had their Norwegian ski, provisions for two months, and necessary instruments for making observations, and they started for the shore. They had to make their way across the glaciers in two months or die. Not before next summer can we have a complete report of the journey; till then we must, with the information we get from two hurriedly written letters which, by mere accident, came over in the last vessel from that region this year. The letter from the mate Sverdrup to his father is given below:

GODTHAAB, *Oct. 4, 1888.*

"Yesterday, after sixty-four days' journey from the east coast, we arrived here all safe. The landing was more difficult than we had calculated. The drifting ice upon which we stepped when leaving the whaler was moving very rapidly toward the south and off from the shore, and it took us twelve days to reach the shore. In that time we had drifted nearly 100 miles. As soon as we had terra firma under foot we started northward along the coast, looking for a place where it would be possible to ascend the solid inland ice. After another twelve days' search we finally found such a place, made our way up without very great difficulty, and on the 16th of August we commenced our westward march. We at first laid our course for Christianshaab (a settlement to the northwest), but when we had reached an elevation of about 7500 feet a terrible snow storm met us, and we concluded to take a more southerly direction toward the Godthaab settlement, as this line would be shorter, and probably would not expose us so severely to the storms from the north. We had, indeed, a hard journey. The terrain in general and the snow were very difficult to walk upon, and the weather was rough. In about three weeks we travelled on an elevation of 10,000 feet in a temperature of 35 to 40° below zero; but we kept moving. Only four days were we held by storms. When we came across and down from the inland ice on the west side we found a stretch of about twenty miles wide free from snow, fifteen miles of which was along the edge of a fiord. We brought the tent and provisions down to the shore and built a camp; further proceeding seemed for a time impossible. Then we made a small boat from part of the tent and a canvas bag. When this boat was ready Dr. Nansen and I started for this place, and after four days' rowing we arrived here, and were very kindly received by the people. Two boats are now sent to the camp, where we left our companions, to bring them down here. The post-ship has left long ago, but some fifty miles farther south there is a steamer, having been acci-

dentally kept back by a breakdown and the storms, now just ready to sail for Copenhagen, and we send two messengers, hoping they will reach the steamer, and perhaps make it wait for us and take us home. We have but very little hope, though, that the steamer will wait, and we shall be compelled to stay here over winter, as this is the last chance this year."

It appears that the steamer did not wait for them, but took the letters and delivered them at Farsund, the nearest port in Norway. The expedition, consequently, must stay in Greenland through the winter, with the prospect of getting plenty of leisure time, and next summer we shall have a full report of this remarkably daring and interesting journey.

GEOLOGY AND PALÆONTOLOGY.

Description of New and Imperfectly Known Species of Brachiopoda, from the Devonian Rocks of Iowa.—Of the Brachiopod Fauna of the Devonian rocks of Iowa, no genus is, perhaps, so variable as the Genus *Atrypa*. Many varieties of *Atrypa recticularis*, of the Iowa strata, are often restricted in their range to certain horizons and localities. For example, at Iowa City, Turkey Creek and Roberts' Ferry, in Johnson county, there occurs in a bed of argillaceous shale a very large and coarse variety of this species, which is not known to appear at any other locality in Iowa, or elsewhere. In some dark bituminous shale at Independence, occurs another variety of the same species, and which is analogous to one of the varieties of the Rockford shales; this form, however, differs from the Rockford shale variety in its very diminutive size.

In the limestone at "Big Bend" of the Iowa river in Johnson county, at Independence, Waverly, etc., occurs another well-marked variety. Many individuals of this variety possess very large thin wings or expansions, the entire shell having a diameter of from five to eleven centimeters; the body of the shell, however, being often only one-half or even one-third that diameter.

At Littleton, in Buchanan county, is found another very distinct variety (a coarse form) whose equivalent is not known to occur at any other locality in the State; its nearest representative, so far as known to me, occurring in the Devonian strata at Louisville, Ky. In the Rockford shales occur two varieties, the smaller of which has the front of the shell so strongly contracted as to produce a dis-

tinct false mesial sinus in the ventral valve. Several other varieties of this species also occur in different portions of the State.

Not only do the Iowa varieties of this species vary greatly in form, size and surface markings, but they also often differ conspicuously in their internal structure. Some forms of this species approach so near to *Atrypa impressa* of the Schoharie Grit of New York, that a strict distinction between them is impossible. *Atrypa reticularis* of the Iowa strata varies so much in form, size, surface marking, etc., that it could be separated into several forms sufficiently distinct to have specific names, if the forms were found only distinct groups of rocks. *Atrypa hystrix* and *Atrypa aspera* also vary greatly in form, size and internal structure. An interesting feature of the Brachiopod and Polyp faunas of the Devonian strata of Iowa, is the occurrence of quite a number of forms which imperceptably grade into one another; but which forms are seen, in the rocks of other States, to constitute well-marked species. This condition is more particularly noticeable among some forms of the genera *Favosites*, *Cyathophyllum*, *Atrypa* and a few others.

Spirifera substrigosa, n. sp.—Shell a little larger than medium, somewhat longer than wide, slightly gibbous; cardinal extremities abruptly produced into short rounded projections. Dorsal valve moderately convex; greatest convexity slightly above the centre. Mesial fold angular, strongly produced in front; marked by five small scarcely elevated rounded plications, only one of which reaches the beak. Valve, on each side of the mesial fold, marked by five strong, broadly rounded radiating plications; cardinal extremities smooth. Ventral valve rather gibbous; greatest convexity about the centre; mesial sinus rounded, of moderate depth, quite rapidly expanding below, and produced into a moderately broad rounded extension; beak much elevated, sharp and strongly incurved; foramen rather large, triangular; area moderately large, concave.

Surface of the ventral valve, on each side of the mesial sinus, marked by six or seven strong, rounded, radiating plications; a small area on the cardinal extremities smooth. Mesial sinus ornamented by four small slightly elevated plications, the two outer ones becoming obsolete a little above the centre of the valve, and the two central ones uniting about the centre of the valve and extending to the beak as one. The front fourth of each valve marked by strong undulating lines of growth; the rest of the surface smooth. This species is more closely allied to *Spirifera strigosa* than to any other described species known to me. Position and locality: Rockford Shales, Hackberry, Iowa.

Spirifera hungerfordi Hall. (Compare with original description, Geology of Iowa, Vol. I, Part 2, p. 501.)—Shell very variable, adult forms often being three and one-fifth centimeters in width,

and about three and one-half centimeters in height; inequivalve hinge line sometimes (in both young and old specimens) extremely produced into wing-like expansions; at other times the hinge line equalling, or much less than the greatest width of the valves below; again, some specimens (old and young) are longer than wide; at other times wider than long, even though the hinge line is not produced.

Dorsal valve generally regularly convex, but sometimes flattened on the cardinal extremity; greatest convexity at or a little above the middle; beak incurved slightly beyond the hinge line; mesial fold often not defined; at other times slightly defined; and rarely strongly and sharply defined in front.

Ventral valve gibbous at or above the middle, having twice as great an elevation as the opposite valve; beak generally much extended above the hinge line, but sometimes scarcely; sharply incurved, or not incurved; sinus sometimes wanting, at other times shallow and scarcely defined above the middle, and producing a slight sinuosity (at times strongly produced) in front; in some specimens with greatly produced hinge lines, the sinus is quite well defined nearly or quite to the beak; area large and well defined, principally confined to the ventral valve, vertically striated; foramen narrow, triangular, extending quite to the open valve, the margins or dental lamellæ often a little projecting. Surface marked by fine rounded radii; radii about equal to the space between them, "and both are again finely striated in the same direction by microscopic lines, and the whole crossed by fine striæ which give a granulated appearance to the uneven surface"; this feature, however, is not always well shown even in well-preserved specimens.

The "dichotomising of the radii on the mesial sinus and fold" is by no means a constant feature. The internal structure of this shell varies considerably in different individuals. The dental lamella, which is usually very strong, generally extends to the centre of the valve, and there becomes obsolete; these lamellæ gradually diverge downward and about the centre of the valve, between them, is a deep heart-shaped muscular impression, marked by four to six more or less prominent vertical striæ; the dental lamellæ sometimes extend to the centre of the shell only as slight elevations along the margins of the muscular impressions; the muscular impressions vary somewhat in size, depth and general form in different specimens.

In some instances, the interior of the ventral valve is distinctly punctate; cardinal processes of dorsal valve rather large, bifid, and fitting into notches in area of ventral valve. Internal spires rather large. Position and locality: Throughout the Rockford Shales, Iowa.

Spirifera strigosa Meek. *Spirifera macra* Meek (1860), Pro-

ceed. Acad. Nat. Sci., Phila., XII, 309. *Spirifera strigosa* Meek (1860), to extra copies of the above cited paper. *Spirifera orestes* Hall and Whitfield (1873), 23d Rept. Board of Regents on N. Y. State cabinet, P. 237, *Spirifera strigosa* Meek (1876), in Col. Simpson's Report Expl. across the Great Basin of Utah, 347, pl. I, figs. 5,a,b,c,d. Compare with description of *Spirifera orestes*, of H. and W., 23d Report of Board of Regents on New York State cabinet of Nat. His., p.237; and also with description of *Spirifera strigosua* Meek, U. S. Geol. Exploration of Fortieth Parallel, Vol. IV., p. 43.

Shell very variable; semielliptical, subouate, suborbicular, longer than wide or wider again than long; of medium or under medium size; often gibbous in young as well as old specimens; frequently greatly extended on the hinge line, sometimes hinge-line one-third less than the greatest width of the valves below; at other times the hinge-line and valves below are equal, valves subequal; greatest convexity of the ventral valve at or slightly above the middle; greatest convexity of the dorsal valve at the centre, or a little above. Beak of ventral valve strong and usually high, sometimes low; from slightly to very sharply incurved; the height, strength and curvature of the beak varies somewhat with the age of the animal; central area high, concave, vertically striated; foramen rather large, triangular, extending to the apex of the valve, the margins or dental lamellae strongly projecting in well-preserved specimens.

Valves marked by very large or small, simple, rounded or angular plications; varying in number from four to thirteen on each side of the mesial fold and sinus, in young as well as adult forms.

Mesial fold and sinus marked by from one to six bifurcating plications (in some instances, the plications do not bifurcate, but run out along the margins of the fold and sinus). Usually the mesial fold is strongly elevated in front and more or less well defined to the beak, but in rare instances, even in adult specimens, the fold is not defined, even in front, although the sinus of the opposite valve is well defined to the beak, and produced in front.

Mesial sinus more or less well defined to the beak, rather rapidly expanding below, and produced in front into a sharp or broadly rounded extension; bottom shallow or deep, angular or rounded. Surface of specimens, with small or medium-sized plications, marked by very fine striæ parallel to the plications; surface of specimens with large, coarse plications, marked by stronger and more numerous oblique striæ, which unite with each other on the summit of the plications and centre of the depressions between the plications, thus giving the entire surface a very sharply zigzag striation; the surface of many specimens are also crossed, in front, by slight lines of growth.

Surface of the interior of the valves smooth or marked by ridges, which correspond to the depressions between the plications on the

exterior of the valves; dental lamellæ in ventral valve slightly produced, sloping abruptly backward and downward, becoming obsolete before reaching the center of the valve; cardinal processes of dorsal valve small, bifid, fitting into notches in area of ventral valve.

This is one of the most variable species of Spirifers known to me. The descriptions of this species, and *Spirifera hungerfordi*, are based upon over one hundred and fifty specimens of each species.—Position and locality: Rockford Shales, Rockford and Hackberry, and Owens Grove, Iowa.

There seems to be no doubt but that this very variable species (designated as *Spirifera orestes*, by H. & W.,) is identical with *Spirifera strigosa* Meek, as described in Vol. IV., p. 43, of the U. S. Geol. Exploration of Fortieth Parallel. This being the case, Meek's name would, therefore, be considered as having the priority.

Atrypa hystrix var. *elongata*, n. var.—Shell of medium size, elongate ovate, valves slightly aud nearly equally convex; greatest convexity of the ventral valve slightly below the umbo; greatest convexity of the dorsal valve on the umob. Beak of the ventral valve of moderate strength, perforate, scarcely raised above the opposite valve; area closed, surfaces marked by from four to five simple rounded ridges upon each valve, crossed by strong thickened concentric laminæ of growth, but which are not elevated at intervals into spine-like protections. This well-marked variety is known to occur at only one locality, the Rockford Shales, at Hackberry, Iowa.

Atrypa hystrix var. *planosulcata*, n. var.—This form differs from *A. hystrix* in the general expression and fineness of the shell. The plications are very much smaller and more numerous, the laminæ of growth usually slight and not generally elevated into spine-like projections. These features are very constant in both young and old specimens.

We were at first inclined to consider this form specifically distinct from *A hystrix*, but after a large number of them had been secured, it proved that they constituted only a well-marked variety of this species.

This variety is common throughout the Rockford Shales, and is also the prevailing form which occurs in the limestone which immediately underlies the shales. We have also secured a very few specimens from some shales at Roberts' Ferry, Solon and Turkey Creek, in Johnson county.—*Clement L. Webster.*

CAVES AND CAVE LIFE.—There are a few statements made in Dr. Packard's article in the September number of the AMERICAN NATURALIST, which, while they do not affect the argument, seem to need

correction. First, on pp. 814–815, occurs the statement: "It is probable that *Cæcidotea stygia* is seldom, if ever, brought in contact with *Asellus communis*, which abounds in the pools and streams throughout the cave region." For this I can see no reason. As I have lived for some time in the cave region, I may say that Cæcidotæa is not confined to "caves and wells fed by underground streams," but occurs in Bloomington in springs and in the ordinary streams, mingling with its near relative Asellus. Again, except for the single element of darkness, I cannot see how the cave fauna, occurring in the numerous caves around this town, and extending south to Wyandotte and Mammoth, "is almost completely isolated from that of the upper world." Too many of the streams in this carboniferous belt drop out of sight, and can be traced directly into caves about here to afford much isolation to aquatic animals.

Not having seen the complete article from which his paper "On Certain Factors of Evolution" is an extract, I do not know on what Dr. Packard bases his conclusion (p. 815) that the cave faunæ are to be regarded as products of Quaternary times. Of course the general facies of that fauna is recent, but it is, on the other hand, beyond question that the caves themselves have been in process of formation since their rocks were elevated above the carboniferous sea. I know of no argument which forbids the idea of their being peopled in Permian times. The fact that we have no cave fossils giving evidence of a Mesozoic fauna is easily explained by the fact that there was no locality for such fossils to form. Caves are constantly being enlarged by a solution of their walls, and with the wearing away of the rock all cave-animal remains would of necessity be destroyed.

While on this subject of caves I may call attention to a few facts which I have observed during the past year in regard to their formation, and I do so the more willingly since I find a belief quite prevalent that they were caused by the "Champlain floods." Southwestern Indiana and Central Kentucky and Tennessee are, *par excellence*, the cave region of America. A few caves have acquired more than local prominence, yet from Bloomington south, one cannot go a dozen miles without striking several caves. Now all this region is below the line of the drift; nowhere in it can one find a single morainic boulder. It is rather a region of topographic old age. The "Knobs" which skirt the Ohio, from Louisville to Evansville, are produced solely by atmospheric agencies, and the same physical features characterize the whole region. In the valleys, to be sure, occur the channels which must have borne off the floods caused by the melting ice of the Continental glaciers, but the river-courses of to-day but occasionally coincide with those which must be invoked to explain the presence of the caves. To explain the existence of the caverns we must predicate streams whose

beds have now entirely disappeared, except as they are shown inside the caves. For instance, the Blue river of to-day cannot be connected with Wyandotte Cave. The entrance to the cave occurs on a side hill, a hundred feet above the present stream, yet inside the cave there is ample evidence, not only of the long-continued action of small amounts of water, but, in places, the plainest signs of a considerable stream. So, too, in Little Wyandotte, a few rods away. Still, where that water entered the cave, and where it made its exit, are as yet unsolved problems. In the majority of caves which I have seen, the entrance seems a secondary formation produced by a falling in of the roof, or a wearing away of the hill itself. This last is clearly the case with Wyandotte Cave, which apparently once had a greater extent than it now has. In other cases the entrance is through a "sink-hole," but it requires no little credulity to believe that that little funnel conducted the water which wore away such a cavern as "Coon's Cave" in this county (Monroe).

Some facts which I have observed, but which I have not seen recorded, seem to show that this cave region formerly contained more caves than now, but that they have disappeared by wearing away of the rock in which they were contained. On the slope of the hill, near the path which leads from the Wyandotte Cave Hotel down to the well at the fort, where the blind fish are found, are apparently the remains of a cave, the walls and roof of which have utterly disappeared, the only traces which remain being the stalagmites on the floor. So, too, on Blue river, about half way from Wyandotte to the Ohio, occur what are known as Castle Rocks, and these turrets, rising several feet above the surrounding country, seem to be the last vestiges of a former cave of considerable dimensions, the other walls of which have been carried away.

These facts, which I have thus jotted down, all go to show that in the Indiana-Kentucky-Tennessee cave region, time has been no inconsiderable element in the process of cavern formation, and I believe that the majority of the caves about here had acquired essentially their present sizes and dimensions long before the appearance of the "great glacier" so often invoked to explain all sorts of phenomena in dynamical geology. That it is not at all adequate to account for the caves is evident to any one who visits this region. Recourse must be had to a time when the whole physical geography was different, and when southwestern Indiana was not cut up into its present condition of steep hills and cañon-like water courses.—*J. S. Kingsley, Bloomington, Ind.*

Goniopholis in the Jurassic of Colorado.—In my essay on the horizons of vertebrate fossils of Europe and North America,

read before the International Congress of Geologists of 1878,[1] I recorded the probable occurrence of this Jurassic genus of Crocodilia in North America. This supposition has become a certainty, as a result of a more detailed examination of material received from Mr. O. W. Lucas, of Canyon City, Colorado. This consists of a nearly entire skull, with numerous portions of the skeleton, derived from the locality which furnished the typical specimens of *Camarasaurus supremus* Cope, and other Reptilia. It appears that the specimen is specifically identical with one which includes vertebræ and a few other bones only, described by me as *Amphicotytus lucasii*,[2] from the same locality. The species may be therefore called *Goniopholis lucasii.*

The superior surfaces of the skull and dormal scuta are rather finely and profoundly pitted. The orbits are a little smaller than the crotaphite foramina, and each one has a strong supraorbital bone, which is also pitted. The muzzle is of moderate length, and is proportioned much as in the Nile crocodile. Its extremity is neither abruptly expanded nor recurved. The anterior teeth are sculptured with coarse, shallow, parallel grooves. Those of the posterior portion of the maxillary bone have opposite angles at the extremities of a transverse axis extending inwards and forwards and outwards and backwards, but the crown is not compressed at the base, though slightly so at the apex. The posterior nares are narrow, and are divided by a median septum. Their anterior border is opposite the middle of the palatomaxillary foramen. The pterygoids terminate posteriorly in a wide, free, transverse margin.

The *Goniopholis lucasii* was equal to a two-thirds grown Mississippi Alligator in dimensions, and its head was of relatively larger size. It was smaller than the *G. crassidensowrn.*

Measurements.

Length of cranium on median line	.385
Length from end of muzzle to line of orbits	.245
Length from end of muzzle to line of crotaphite foramina	.310
Width of cranium between quadrates inclusive	.250
" " table of cranium	.110
" " parietal space	.015
" " interorbital space	.040
" " muzzle at front of orbits	.110
" " muzzle at nares	.090
Length of fore part of pseudocanine tooth	.035
Width of fore part at base of crown	.013

E. D. Cope.

AMERICAN FOSSIL CRYPTOGAMIA.—At a meeting of the Biological Society of Washington on Nov. 17th, Prof. L. F. Ward read a paper,

[1] Comptes Rendus Stenographiques, Paris, p. 146; Vertebrata Tertiary of the United States, 1885, p. 26.
[2] Bulletin U. S. Geolog. Survey Trans. F. V. Hayden, 1878, p. 391.

on "A comprehensive type of fossil cryptogamic life from the Fort Union group," illustrating it by lantern views. The fossil in question was so peculiar that though collected in 1883, he had done little with it until the present season. Photographs of it were sent to various eminent zoologists and botanists, with a view of determining the affinities of the curious specimen. Zoologists could not refer it to any animal, and so considered it a plant; while botanists, knowing no plant like it, thought it possibly an animal. Prof. Ward's conclusion so far is that it represents a generalized type of vascular cryptogam, with relationships to Ophioglossum, Isoetes, Marsilea, Lycopodium and Selaginella. It is evidently an aquatic, fresh water, as shown by the remains of aquatics in the same connection. A central, roundish rhizoma or rhizoid, is surrounded by slender, flexuous bodies, radiating in all directions, each expanding from a rather narrow base to a broad club-like end. The scales are arranged in two or three rows; at the base are found numerous round bodies like spore cases, and the free end has a flattened blade about twice as wide as the main stem and rounded. In the general aspect of the rhizoma it is related to Isoetes. In its branches and fructification to Ophioglossum and Marsilea, and in its scales to Lycopodium and Selaginella. Letters from Prof. Farlow, Dr. Nathorst and Count Saporta, were read, and these scientists suggested a possible connection with the same forms of cryptogams as Prof. Ward had himself imagined. In a discussion which ensued, Prof. Seaman called attention to the similarity the specimens presented to the structure of the hairs of *Drosera rotundifolia.* It would indeed be strange if in this fossil plant of Cretaceous times we should have foreshadowed and produced on a large scale the hairs of Drosera, each acting independently instead of working in common. It must be said, however, that the chances are greatly in favor of the view of Prof. Ward, that it is a generalized form of certain groups of the vascular cryptogams.—*Jos. F. James.*

A Horned Dinosaurian Reptile.—In the December number of the *American Journal of Science and Arts*, Prof. O. C. Marsh describes parts of the skeleton of a Dinosaur from the Laramie formation of Montana, including parts of the skull. The latter is remarkable in supporting on its posterior part a robust horn-core on each side, somewhat like that of the ruminating mammals. Prof. Marsh concludes that the genus to which this animal belongs is allied to Hypsirhophus (Stegossaurus) of the Jurassic. This interesting discovery of Prof. Marsh will solve a problem which has remained unsettled for over ten years. In 1877, in the *Bulletin of the U. S. Geological Survey* of the Territories, Vol. III., p. 588, the present writer described parts of the skull of this animal and figured some

of them, including a horn-core and posterior part of the skull (Plate XXXII., fig. 8). These fragments were also found in the Laramie bed of Montana, probably at no great distance from those described by Prof. Marsh. I did not determine the genus to which this cranium should be referred, since there were already known nine genera of Dinosauria from the same horizon to one or the other of which, it was sure to belong. The observations of Prof. Marsh will determine this point. The affinity to Hypsirhophus referred to by Prof. Marsh indicates Polyonax (Cope) as the form to which the species probably belongs, although this is of course a mere surmise. That genus was described from vertebræ and limb and dermal bones (Cretaceous Vertebrata U. S. Geol. Survey Terri., II., p. 63, Plates II. and III.). Some of the latter were probably identified with doubt as parts of the shafts of limb bones, but they resemble more nearly some of the spinous dermal bones ascribed to Hypsirhophus by Marsh.

It would have been well if the final publications of the Hayden Survey could have been completed by the Director who succeeded him in charge, instead of new publications taken up. In that case the continued duplication of the work of the first survey by its successor could have been avoided.—*E. D. Cope.*

MINERALOGY AND PETROGRAPHY.[1]

Petrographical News.—Löwinson-Lessing[2] has suggested a scheme for the classification of elastic rocks. He would divide these into tuffs, breccias, conglomerates, pseudoschists and slaty rocks. Tuffs he would confine to rocks made up of crystals, or pieces of crystals, and separate minerals, and would subdivide into agglomerates-tuffs (subaëreal) and tuffogenous sediments (submarine). The agglomeratic tuffs he would further separate according to structure. Tuff-like rocks produced from crystalline rocks by orodynamic forces, or by weathering, he would call tuffoids, and distinguish as elasto-tuffs and decomposition-tuffs (Verwitterungs tuffen). The breccias are composed of pieces of rocks cemented by rock material. They are divided into primary, or volcanic, and secondary, or metasomatic breccias. The volcanic breccias include the lava agglomerates (Reibung's breccias), composed of pieces of foreign rock, or of the crust of a lava stream, which have been cemented together by a molten rock, and tuff-lavas (Spaltung's breccia),

[1] Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.
[2] Miner. u. Petrog. Mitth., ix., p. 528.

those produced by the separating from a molten magma of certain portions, and their consolidation into a rock mass by the cooling of the remaining portion. Both of these classes are again subdivided according to structure. The conglomerates include the conglomerates proper, psammite (a micro-conglomerate) and sandstone (when the microscopical grains are those of single minerals). The pseudoschists are metamorphosed sediments, breccias, or tuffs in which the line between the fragments and the cement has partially disappeared. The slates have the same signification as at present. —The basalt forming two hills near the village of Grossdehsaer, west of Löbau, in Saxony, contains numerous inclusions of granite which possess features of great interest. The basalt is composed of a mesh of augite crystals and a little glass, in which porphyritic augites, olivine, magnetite and a little plagioclase are imbedded. It contains also little veins of a colorless substance, with the chemical properties of nepheline. The basalt in breaking through the underlying granite brought pieces of the rock with it to the surface. The changes which have been produced in these included fragments and the effect which they in turn have produced in the basalt, are the occasion of a recent paper by Beyer.[1] The inclusions are divided into the porphyritic and glassy varieties. The basalt first disintegrated the granite, and then separated the broken fragments into their constituent minerals. These were then partially dissolved —the mica disappeared entirely and magnetite and spinel were developed; in the vicinity of feldspar new feldspathic material crystallized; the quartz was corroded and around its edges a light colored augite was formed. In the porphyritic inclusions remains of quartz and feldspar are still to be found; in the glassy ones all traces of the original minerals have disappeared, the composition of the glass alone remaining as proof of the granitic character of the inclusion. The effect of the inclusions upon the basalt is seen in the disappearance of the olivine, and the development in its stead of a brown glass surrounded by augite crystals. In the more acid portions feldspar has separated and has included many microlites of augite within itself. While these changes were going on in the granite and basalt, steam escaped from the mass of rock and produced a slaggy condition in the glass inclusions, and new minerals which are implanted in the walls of the cavities. In one case little colorless hexagonal crystals have the composition:—

SiO_2	Al_2O_3	CaO	MgO	K_2O	Na_2O	H_2O
57.50	18.11	4.63	1.20	6.98	2.40	10.48.

—The islands off the coast of Morbihan, France, contain strata of

[1] Miner. u. Petrog. Mitth., x., p. 1.

schistose pyroxene rocks, interbedded with archæan gneisses and mica-schists. They consist of sphene, garnet, green pyroxene, plagioclase, quartz, mica and pale hornblende in large crystals. Vesuvianite and zircon also occur in them in small quantity. The pyroxene, comprising the larger part of the rock, is of a light green color, and possesses the diallagic parting. The plagioclase—labradorite and anorrhite—is present in large quantity in some varieties of the rock, and always shows a tendency to alter into wollastonite. The hornblende and quartz are both secondary. These pyroxenites resemble very closely the flaser-gabbros of the Germans, but are supposed by Barrois[1] to be metamorposed limestones. He describes a limestone in contact with granite in the same region, in which the minerals characteristic of the pyroxenites have been developed.—Chrustschoff[2] includes under the name perthitophyre a series of dyke rocks occurring in the Department Volhynia, Russia, whose characteristics differ from those of any rocks heretofore described. They consist of an interstitial micropesthitic substance, in which various amounts of idiomorphic quartz, labradorite, monoclinic and orthorhombic augite, olivine, and other minerals are imbedded. In the coarser varieties the iron-bearing minerals are not abundant, while in the finer grained kinds they are in as large quantity as the feldspar. In the course of his article the author describes parallel growths of diallage and acicular crystals of an orthorhombic pyroxene, and also an apparently triclinic pyroxene. He also mentions the existence of anatase as an inclusion in the feldspar and quartz, and gives in brief the properties of a mineral whose nature he is unable to determine.—Sandberger[3] describes inclusions of hypersthenite, olivine-gabbro, and a rock composed of olivine, arfvedsonite, picotite, eustatite, sanidine and augite, from the phenolite of Heldburg, in the Thüringer Wald.—Pošepuy[5] gives brief descriptions of a few sections of adniole in the course of an article discussing the structure of the well-known mining region in the vicinity of Przibram, Bohemia.

American Minerals.—A series of analyses[4] of *beryl* from Norway, Maine and Willemantic and Litchfield counties, Ct., seems to show that beryllium and the alkalies mutually replace each other in this mineral, and that water is a constant constituent. An analysis of *phenacite* from Florissant, Col., gave practically no alkalies. The barium feldspar (*cassinite*) from Bene Hill, Delaware county, Pa., first analyzed by Genth,[5] has been re-examined by

[1] Barrois: Ann. d. l. Soc. Geol. du Nord., xv., p. 69.
[2] Miner. und Petrog. Mitth., ix., p. 470.
[3] Neues Jahrb. f. Min., etc., 1888, ii., p. 24.
[4] Miner. u. Petrog. Mitth., x., p. 175.
[5] Report Min. Penn., 1866, p. 224.

Penfield and Sperry,[1] and found to have the composition :—

SiO_2	Al_2O_3	Fe_2O_3	CaO	Na_2O	BaO	K_2O	Ign.
62.95	19.82	.17	.25	4.01	3.95	8.57	.11

a result agreeing very closely with that of Genth. The authors regard the substance as a mixture of 35.23 per cent. albite, 51.15 of orthoclase, and 13.17 of hyalophane. The microscopical examination of its thin sections reveals the presence of albite lamellæ ntergrown with orthoclase, but does not show the hyalophane. analyses of *monazite* from Alexander county, N. C., of sussexite from Franklin, N. J., and of a very pure phlogopite from Edwards, St. Lawrence county, N. Y., are given in the same article.—Wülping[2] has used the results obtained by Riggs[3] in his careful analyses of tourmaline, to determine a general formula for the composition of this complex mineral. By reducing the amounts of the various substances found by Riggs to their equivalents in SiO_2, B_2O_3, Al_2O_3, MgO, Na_2O and H_2O, Wülping[5] concludes that the mineral may be represented as a compound of the molecules 12 SiO_2, 3 B_2O_3, 8 Al_2O_3, 2 Na_2O, 4 H_2O, and 12 SiO_2, 3 B_2O_3, 5 Al_2O_3, 12 MgO, 3 H_2O, in various proportions.—Crystals of *phenacite* from Mt. Antero, Col., present two habits. Those found in quartz or beryl consist essentially of rhombohedra of the third order, combined with prisms of the second order, while those attached to orthoclase show in addition a prism of the first order. The rhombohedral faces are dull, and the prismatic faces are vertically striated. Twin crystals of quartz with P_2 as the twinning plane are also described. —A remarkable variety of *oligoclase* from near Bakersville, N. C., is described by Kunz[6] as perfectly transparent. It has a faint green tinge, and contains cavities surrounded by tufts of white acicular microlites, like the glass that often solidifies in the bottoms of glass pots. It has the usual perfect cleavage of oligoclase, but is not striated. According to Messrs. Penfield and Sperry,[7] the optical properties of the mineral are abnormal. Sections parallel to oP show a positive extinction of 39°–40°. Those parallel to $\infty P\acute{}\infty$ remain dark during an entire revolution between crossed nicols, but in converged light yield an optical axis in the centre of the field instead of a bisectrix. The same writer calls attention to *quartz* pseudomorphs after spodumene from Peru, Me.; pseudomorphs of *iron oxides* after aragonite from Puma Co., Ariz., and beautiful transparent *cyanite* from Bakersville, N. C.—Crosby and Greeley

[1] Amer. Jour. Sci., xxxvi., p. 317.
[2] Miner. u. Petrog. Mitth., x., p. 161.
[3] Amer. Naturalist, 1888, p. 250.
[4] Amer. Jour. Sci., xxxvi., p. 321.
[5] Ib., p. 222.
[6] Amer. Jour. Sci., xxxvi., p. 324.
[7] Technology Quarterly, May, 1888, p. 407.

have discovered that the brown massive mineral from Newbury, Mass., and regarded by Dana as garnet, is vesuvianite. It has a specific gravity of 3.55 and a composition :—

SiO_2	Al_2O_3	FeO	CaO	MgO	K_2O	Na_2O	MuO_2	P_2O_5
35.93	14.77	8.91	39.46	.13	.44	.36	tr.	tr.

—A hard black mineral occurring at Rome, Mass., in little octahedra, has been examined by Crosby and Brown,[1] with sufficient accuracy to lead them to declare it gahnite.

MINERAL SYNTHESES.—Dollter[2] has effected the synthesis of a large number of *micas* by fusing together aluminium-bearing silicates and metallic fluorides. The hornblendes yielded biotite when fused with sodium and magnesium fluorides. The alumina-free hornblendes gave olivine or augite. Garnets yielded meroxane. Micas of different kinds were obtained by fusing K, Al, SiO_4 with sodium fluoride alone; or with this salt and potassium fluosilicate or magnesium silicate, with or without the addition of ferrous silicate. All the micas thus produced were decomposed when the temperature of the mass was raised to a white heat, and olivine, augite or scapolite were formed. Muscovite was obtained from andalusite by fusing it with potassium fluosilicate and aluminium fluoride, and zinnwaldite, when a little lithium carbonate was added to the mixture. Many other points of interest are found in the paper, which will undoubtedly prove of value in discussing the paragenesis of minerals in rock masses.—Among the other minerals produced artificially within the past few months, attention may be called to *rhodonite* and *tephronite*, which Gorgen[3] obtained by heating to a high temperature, in the presence of water vapor, a mixture of manganese chloride and precipitated silica. Wollastonite[4] was produced when calcium chloride was used instead of the manganese compound. *Barite, celestite* and *anhydrite* were obtained[5] by fusing the corresponding amorphous compounds in the chloride of some metal.—Bourgeois[6] fused metallic tin with copper oxide and got crystals of *cassiterite.*—Dufet[7] prepared *pharmacolite* by allowing solutions of calcium[8] nitrate and di-sodium arsenate to diffuse slowly into each other.

MISCELLANEOUS.—Julien believes that the rate of decomposition in pyrite depends upon the amount of marcasite present in it

[1] Ib., p. 408.
[2] Min. und Petrog. Mitth., x., p. 67, and Neues Jahrb. f. Min., etc., 1888, ii., p. 178.
[3] Bull. Soc. Franç. d. Min., x., p. 264.
[4] Ib., x., p. 271.
[5] Ib., xi., p. 58.
[6] Ib., x., p. 284.
[7] Ib., xi., p. 187.
[8] Ann. N. Y. Acad. of Sci., iv., July, 1888.

Easily decomposable pyrite is not pure, but is intimately mixed with marcasite, probably in the most minute, *i.e.*, molecular condition. The more rapid alteration of marcasite is supposed to be due to the open structure of the mineral in consequence of the interlacing of twinned crystals, etc.—Mr. Dunnington[1] thinks that the origin of the massive oxides of manganese may be explained by reference to the well-known dissolving effect of sulphate solutions upon manganese compounds. The sulphates may easily have been derived by the decomposition of pyrites. This theory would account for the great depth at which certain deposits of manganese ores are found, and their concentration in masses.—In an article extending through several numbers of *Nature*, Lockyer[2] gives an interesting résumé of the state of our knowledge in regard to meteorites—their structure, composition and origin.—Rauff[3] announces the invention of a new rock slicing machine, and an instrument for cutting crystals parallel or perpendicular to any given natural face.

BOTANY.[4]

A FEW NOTABLE WEEDS OF THE NEBRASKA PLAINS.—In examining the constitution of various floræ one is struck by the fact that with the other changes there is a notable change in the weedy plants as well. Of course a "weed," from a botanical standpoint, is as reputable a plant as any other. It is in fact but an eminently successful organism in the struggle for place, and on this account it is to the botanist much more interesting than the ordinary plants which jog along in a mediocre way, neither advancing nor falling much behind under our observation. Upon the Nebraska plains, the plants which push themselves into place so prominently as to be called "weeds" by the farmer, are partly natives, and partly introduced species, some of which have come in from the southwest within a comparatively recent period, while others have come along with the tide of immigration from the eastern part of the continent, and from the old world.

The plant which, all things considered, is the worst weed, from the popular point of view, is doubtless the Sand-bur (*Cenchrus tribuloides* L.), a peculiar grass of variable habit. As mostly seen,

[1] Amer. Jour. Sci., Sept., 1888, p. 175.
[2] Ib., Sept., 1888.
[3] Neues Jahrb. f. Min., etc., 1888, ii., p. 230.
[4] Edited by Prof Chas. E. Bessey, Lincoln, Neb.

growing almost horizontally from their bases, but when grown in a dense mass it is a tall, erect grass, reaching the height of eighteen to twenty-four inches, or even more. The heads consist of numerous it is a small plant of a spreading habit, the short flowering stems often spiny flower clusters, which become easily deciduous upon the ripening of the seeds. The spines cause these to adhere tenaciously to the hair of animals or to the garments of the passer-by, and when abundant it is almost impossible to remove them until by hard usage the spines have become worn and broken. The seeds are thus carried long distances before being dropped. The plants thrive upon any soil, from the almost barren sands of the rivers to the rich loam turned up by the railway builders in making their embankments. I am of the opinion that the Sand-bur originally grew upon the sandy islands and banks of the Republican, Platte, Loup, Elkhorn, Niobrara and Missouri rivers, and that from them it has spread since man has broken the tough sod of the plains. It could not compete single-handed with the wild grasses, but as soon as the farmer began his warfare against the latter, the Sand-bur found and improved its opportunity for extending its habitat. The farmer has unintentionally and unconsciously given it the opportunity of going up and taking possession of the land.

Buffalo-bur (*Solanum rostratum* Dunal) is the only appropriate name given to a pest which is rapidly increasing all over the plains. The prickly plant and fruits are almost as troublesome as the Sand-bur. I have seen fields in south central Nebraska almost completely filled with Buffalo-burs. What its original habitat was I do not know, but certain it is that now the plant is accommodating itself to the new conditions brought about by the cultivation of the soil.

The sunflower of the plains is the original of the ordinary sunflower of the gardens (*Helianthus annuus* L.). It is found everywhere, and varies in height from a few inches to fifteen feet or more. Upon the unbroken prairies in the White River country of northwest Nebraska I have seen it growing with the prairie grasses, where it consisted of a single erect stem, not more than ten or twelve inches in height, and bearing a single small flower head. Near by, where the soil had been somewhat broken, as by the washing of water, the pawing of buffaloes, the passage of a wagon, or any other cause, the plants were taller, and with a few branches. Upon the mounds made by the prairie dogs, pocket gophers, and ground squirrels, the plants were still larger, approaching the vigor of vegetation shown by them in the eastern parts of the State. In the settled portions of the State the sunflower grows to a great size, and produces a multitude of branches and flower heads. I have often seen plants whose diameter (measured from the tips of the branches on each side) was fully six feet, and whose height reached

twelve to fifteen feet. It is a curious fact that all over the plains there is a tradition that the sunflower was introduced by the Mormons, who scattered its seeds by their trails, in order to enable the faithful who came later to follow their tracks. It is scarcely necessary to say that this is an error. The sunflower doubtless sprang up in abundance along the Mormon trail, and marked it, but so it did along every trail where the sod had been broken enough to give the plants a better opportunity for growth.

Squirrel-tail grass, as it is called in the books, and in classes in botany, or "Tickle grass," as known to the farmers (*Hordeum jubatum* L. of the botanists), is one of the most abundant of the weedy grasses of the plains. It appears to have originally grown along the sandy margins of rivers, and upon the bare ground about ponds and salt springs, from whence it has spread rapidly to road sides and fields since the advent of white men. It is not naturally one of the prairie grasses proper. In fact, as it is an annual, it cannot compete successfully with the strong-rooted perennial grasses until the latter have been partially displaced by the breaking of the sod; but when once it obtains a foothold it spreads with great rapidity. The jointed rhachis of the head breaks readily into short pieces, each of which bears a few flowers with their widely spreading barbed arrows. Each fragment has a most persistent creeping power, which enables it to work its way through heavy clothing, and the densest of hair or wool. In this way the grains are carried by man and animals for long distances, and when finally the arrows are broken up, and the barbs come out, the seeds are dropped upon the ground, ready to start up in early spring.

Tumble-weeds abound everywhere now, but I am confident that they are likewise dependent for their present abundance upon man's agency in breaking the original sod. The most common tumbleweed is *Amarantus albus* L., well known throughout the prairies and plains. Wherever a settler has broken up a tract of land these plants appear in great numbers; in fact it is principally upon such breakings that they are to be found. In the autumn I have seen great tracts of from fifty to a hundred acres or more entirely covered with the hemispherical or almost spherical examples of these tumble-weeds. With the advent of the frosts and heavy winds of October and November, the stems are broken off at the ground, or in some cases the root is pulled up or twisted off, setting free the round body, which then goes tumbling and bounding over the plains, scattering its seeds as it goes. Whether these tumble-weeds occur as depauperate plants upon the plains, intermingled with the grasses, I do not know, but it is certain that none occur there large enough to roll and tumble. The plant is not a *tumble* weed until it has the opportunity of growing freely upon broken and disturbed soil.

A second tumble-weed is *Cycloloma platyphyllum* Moq. It grows in almost exactly the same way as the preceding. I first observed it along the Platte River, where it covered acre after acre of the sandy river border. It occurs also on the upper Elkhorn River and the lower and middle portion of the Niobrara. However, upon the upper Niobrara and in the White River country the only tumble-weed is *Amarantus albus.* Probably this second plant (Cycloloma) has for a long time been a tumble-weed upon the plains, especially on those portions adjacent to the streams mentioned. Both species will increase in numbers for a few years, during the time when settlers are breaking up large tracts of the prairie sod, and then, as better and more continuous culture is practiced, they will gradually decrease in number and importance.—*Charles E. Bessey.*

Ash Rust in 1888.—The Ash-rust, *Æcidium fraxini,* has been very abundant on *Fraxinus viridis* in Lincoln, Neb., this year. It was especially common in the latter part of June and first week of July. At that time I observed a number of trees of which almost every leaf (as also in many cases were the petioles) was affected to such a degree that many of them were curled and distorted. This has some interest from the fact that, although abundant in 1885, this rust was rare in 1886 and 1887.—*N. R. Pound.*

Hough's American Woods.—During the summer Mr. Romeyn B. Hough, of Lowville, N. Y., brought out Part I. of his proposed work on American Woods, exhibited by actual specimens, and with a copious explanatory text.

The specimens, of which there are twenty-seven, consist of three thin sections, viz., transverse, radial, and tangential, each about four and a half inches by one and three quarters. They are neatly mounted in black cardboard frames, six by nine inches. Upon these frames are printed the scientific name, the various English, German, French and Spanish popular names.

The text is a pamphlet of eighty pages, neatly printed, and illustrated with forty-two wood-cuts. The introductory portion includes an account of the structure of the stem leaf, inflorescence, flower, fruit and seed, with definitions of the technical terms necessarily used in their description. There is also a short discussion of the physical properties of woods. Then follows an index-glossary. Forty pages are devoted to a systematic study of the species represented in the sections. Under each species there is first a specific description of the tree given in quite popular language; then follow geographical distribution, physical properties, uses, medicinal properties, etc. Accompanying this part are three keys to the species: the first based mainly upon the flowers, the second upon the

leaves, and the third upon the fruit. The work will be a most valuable one, and it is to be hoped that it will be continued to completion. Every botanical department ought to afford this set, as the price ($5 per volume) is very reasonable. The volumes are put up in book form, so that they may be placed upon ordinary library shelves.—*Charles E. Bessey.*

ZOOLOGY.

THE CONTRACTILE VACUOLE.—The dispute regarding the nature of the contractile vacuole in the protozoa is not at an end. Dr. De Bruyne records (*Bulletin Roy. Acad. Sci. Belg.* LVI., 1888), his belief that it does not communicate with the exterior, and that it is not possessed of excretory functions. Prolonged study tends to show that the contained fluid is not expelled from the protozoan, but that it is forced to other parts, to again return to form the vacuole. He would rather regard it as of respiratory and circulatory functions and thinks that the contained fluid may possibly have nutrient properties.

★ AN ENDOPARASITE OF AMPHIURA.—Dr. Fewkes records (*Proc. Boston Soc'y. Nat. Hist.*, XXIV., p. 31, 1888) the existence of a Copepod Crustacean parasitic in the brood cavity of the common Brittle Star, *Amphiura squamata*, at Newport, R. I. In the specimens affected the ovary had degenerated into an amorphous mass and that the cavity contained either the adult Copepod or eggs containing the young in all stages of development. Fewkes also records the existence of this parasite in another place (*Bulletin, M. C. Z.*, XIII., 1887) but does not give it a description or a name. Comparison should be made with *Cancerilla tubulata* which is described by A. Giard (*Comptes Rendus*, 1887, p. 1189) as parasitic *upon* the same brittle star at Fécamp. There the young attach themselves to the ends of the anus and approach the disc as they grow older.

THE CLASSIFICATION OF THE MYRIAPODA.—So far as I am aware, no naturalist has questioned the naturalness and homogeneity of the group of Myriapoda. To me it seems that this unity is apparent rather than real; that the Chilopods and Chilognaths are placed together on account of superficial resemblances, rather than from community of descent, upon which all true classification must be based, and that those features which they have in common are at the same time possessed by all the other air-breathing arthropods.

Every zoologist who has essayed the problem of homology presented by the head and the appendages, has made a more or less conspicuous failure, and this, as I am inclined to believe, has resulted solely from the fact that there is no true homology in these parts. I will not now discuss these points in detail, but will indicate the facts and reasons for my views.

A perfect definition should include all the objects intended to be defined, and at the same time exclude all others. Applying this we find it all but impossible in few or many words to frame a definition which will at once characterize all myriapods, and exclude the hexapods, and at the same time take into account structures which have any morphological value. The best we can do is somewhat after this fashion:—Myriapods are air-breathing Arthropods, with elongate bodies and more than three pairs of walking legs. Farther than this we cannot go, and even this definition will admit Scolopendrella which many now regard as a Thysanure.

Omitting for the present all mention of these features which all Myriapods have in common, we will take up the points of difference between Chilopods and Chilognaths.[1] The Chilognatha (Millepods, galley worms) have a head which bears, besides antennæ, only two pairs of appendages—a pair of jaws or mandibles, and an under-lip composed of the coalesced first maxillæ. To the head succeeds the more or less elongate equally segmented body of which a few anterior segments bear but a single pair of legs, while all the rest bear two pairs of appendages, thus apparently affording an exception to Savigny's law that each segment of an Arthropod can bear but a single pair of appendages. The bases of these legs are placed close to each other, the sternal surface being reduced to an extremely narrow plate, or being entirely wanting.

In the Chilopods, on the other hand, the head bears three pairs of mouth-parts, a pair of mandibles and two pairs of maxillæ while each segment of the body bears but a single pair of walking legs, and these are widely separated at their base by the broad sternal element. Numerous attempts, as was said above, have been made to introduce homology between these two groups in these respects. Heathcotes researches show [2] that that the diplopodous segments

[2] Phila Trans. Vol. clxxix., B. (1888).

of Iulus are in reality double, but they also show that in the head there are no traces of more than two pairs of post-oral appendages.

In the Chilopods the Stigmata which communicate with the trachea, are placed at the sides of the body in the thin membrane joining the dorsal and ventral plates, thus being clearly above and outside the line of the legs; in Scutiger they are dorsal. In the Chilog-

[1] Pauropus and the Pauropida are omitted because we know almost nothing of their internal structure and their development.

gnaths the stigmata are placed beneath or even in the coxal joints of the legs.

In the genital organs the most marked differences occur. In the Chilognaths both ovary and testis consist of a simple sac-like organ, communicating by a double oviduct or vas deferens with the paired genital openings situated one on either side, at or behind the bases of the second pair of legs. In the Chilopods, on the other hand, the sexual organs possess but a single efferent duct, and this opens in the middle line of the posterior end of the body just below and in front of the anus. In the Chilognaths both ovary and testis are below the intestine, a position indicating inferiority. In the Chilopods they have their origin in the same position which they permanently occupy in the other group, but with development they come to occupy a place above the alimentary tract. The spermatozoa, in the Chilognaths, are quiescent; in the Chiolopods they are active. The position and character of the genital ducts in the Chilognaths is such as to lead to the supposition that here, as in many other metameric forms, they may have had their origin in a pair of segmental organs which have become specialised for carrying away the generative products. Heathcote's account of the development of the generative glands of Iulus certainly does not oppose this view. In the Chilopods, on the contrary, there is nothing in the adult structure (we know nothing of the development) which would even suggest such an origin for the generative ducts.

Now these points are all of considerable morphological importance, as we must, for instance, go far back in the ancestry to find a condition from which we can derive the two types of generative organs mentioned above, and exactly what structure that ancestor must have had it is difficult to say. It is, however, clearly impossible to derive either condition occurring in the Myriapods from the other.

If, however, we turn to existing forms to find the nearest relations of either group, our search is to a certain extent easy, for the next of kin of the Chilopods are certainly found in the Hexapoda. In all those points where Chilopods and Chilognaths disagree, the Chilopods and Hexapods are in harmony. Both have the same number of mouth-parts; both have the appendages segmentally arranged; the spiracles the same, while there is no little similarity between genital organs, ducts, and openings. Indeed taking Scolopendrella into consideration, it seems impossible to frame a definition which will serve to separate all the Hexapods from the Chilopods. It would seem then that we should unite both Chilopods and Hexapods in one class.

With regard to the Chilognaths, it seems not so easy to trace relationships. So far as is apparent, they form a group by themselves with no nearer affinities than those presented by the Anne-

lids. Peripatus, of which so much was expected in throwing light upon the origin of the "Tracheates" seems to fail in this respect, and must be regarded as nearer to the Annelids than to either Myriapod or Hexapod stock.—*J. S. Kingsley.*

BLOOD CORPUSCLES OF THE LAMPREY. — S. H. Gage states (*The Microscope,* VIII.) that the blood corpuscles of the lamprey are unlike those of the non mammalian vertebrates and like the mammals in being biconcave, circular and in forming rouleaux. They, however, possess a distinct nucleus, not easily seen in the fresh blood, but rendered visible by staining and by reagents.

FIBRES OF SHORT MUSCLES. — In order to ascertain whether the statement made by Kölliker that in the short muscles of the fish, frog and bat, the fibres are of the same length as the muscle, and have rounded ends, is applicable to the more minute vertebrates, Mrs. S. P. Gage has studied the muscles of the mouse, shrew, bat and English sparrow. She concludes (*The Microscope,* VIII.) that the muscular fibres may extend from end to end or may terminate at one or both ends within the muscle, tapering to a point. She further shows that in the muscle fibres even in the limbs and trunk the fibre may branch at either end and that anastamoses may occur between two adjacent muscle fibres in the mouse; and concludes that the difference between the skeletal and cardiac muscles is not so great as has been supposed.

NOTES ON THE AMERICAN TRIONYCHIDÆ. — According to Agassiz there are six species of American Trionychidæ, belonging to three different genera.

I am indebted to Prof. G. Brown Goode and Mr. F. A. Lucas, of the Smithsonian Institution; to Prof. A. Agassiz and Dr. S. Garman, of the Museum of Comparative Zoology in Cambridge;[1] to Prof. A. Gunther and Mr. G. A. Boulenger, of the British Museum, to Prof. O. C. Marsh, of the Peabody Museum, to Mr. T. Gillespie, of Hard Times Landing, La.; for the opportunity they have given me to examine a great number of American Trionychidæ.

As a preliminary report I may note the following conclusions:—

1. The type of *Testudo ferox* Schneider, described by Garden=Pennant in the Philosophical Transactions of London for 1771, is not *Platypeltis* of Agassiz; but a species of *Aspidonectes.*

2. *Platypeltis ferox* of Agassiz is not *Testudo ferox* Schneider, bnt a new species, which may be called *Platypeltis Agassizii.*

3. *Callinia microcephala* Gray, of the British Museum, with the locality Sarawak, is *Amyda mutica* Les.

[1] To Prof. Angelo Heilprin of the Philadelphia Academy.

According to my researches there are the following American Tronychidæ.

Platypeltis Agass.

1. *Playpeltis agassizii* mihi. = *Platypeltis ferox* Agass. non Schneider.

Aspidonectes Wagler.

2. *A. ferox* Schneider.
3. *A. asper* Ag.
4. *A. spinifer*, Les. = *A. nuchalis* Ag.
5. *A. emoryi* Ag.
6. *A. muticus* Les.

At the same time I should like to call attention to the enormous sexual difference in *Aspidonectes muticus* Les. It is well-known that the males have very much longer tails than the females on all the Trionychidæ. The male of *A. muticus* has the plastron more developed than the female: the Hyo-, and Hypoplastra meet with the callosities nearly in the median line. The callosities extend very much more in the male than in the female; in an adult male the callosities cover the plastral-bones entirely A very peculiar circumstance is, that the adult male is only about half as large as the adult female and that the males are in considerably smaller number than the females. Among thirty-six specimens of *A. muticus* from the Ohio River, there were only *seven* males. The fishermen consider the males and females as different kinds of animals, so great is the difference.

I do not know yet, whether the other Trionychidæ show the same considerable sexual difference. It is very interesting, however, that *Podocnemis* shows it.

Toao Martins da Silva Coutinho,[1] makes the following remarks about the male of *Podocnemis expansa*.

"The male, named *Capitary*, is distinguished from the female, by its size; it is only about 0, 7 m long (the female 1, 2m and more) and the tail which is twice as long, reaches a length of 1. 2 m.—The circumstance that only a small number ot *Capitary* are found among hundreds of females, proves, in some way, that a single male is sufficient for the fecundation of a greater number of females."—*G. Baur, New Haven, Conn.*

McGee on Meadow Larks and Riley on English Sparrows.—At a meeting of the American Ornithologists' Union, held in the hall of the National Museum in Washington, Prof. McGee, of the Geological Survey, read a paper detailing his observations upon the two forms of North American meadow larks, as found in Iowa.

[1] Sur les Tortues de l'Amazone, Bulletin de la Société Imperial d'acclimatation, Avril, 1868.

The two species or geographical varieties, whichever they may be, are distinguished by certain peculiarities in their song. The eastern species, *Sturnella magna,* extends about two-thirds way across the State of Iowa, while the western form, *S. neglecta,* is found nearly as far east as the Mississippi River. At their extremes of distribution both of the forms are easily recognized, and are typical examples. But in the intervening region, where the two overlaps, as it were, the birds were not to be positively separated by note alone, a sight of the bird itself being generally necessary for positive identification. Whether the variation in song was due to imitation of one by the other or to an actual intermingling of the two, he did not attempt to decide. In referring to the reason for the distribution of the two species, the agency of the glacial period was evoked. At the time when the ice reached its greatest extension southward, the waters of the Gulf of Mexico extended northward, forming a junction with the ice and dividing the continent into an eastern and a western portion. The suggestion was made that if at a period anterior to the glacial epoch one species was widely distributed over the continent, the time that elapsed until the normal condition of the country was again reached was sufficiently long to allow differentiation to proceed, and two species or distinct varieties to be formed.

In the discussion which ensued Dr. Cones took the ground that a very long period of times was not absolutely necessary for the formation of new races, varieties or species: that environment or food often causes changes with considerable rapidity, and that it is probable new species, so-called, are being formed under changing conditions in our own day and in short periods of time. Dr. Merriam mentioned that changes in coloration are often due to change of food: that a breeder in Holland was so well known for his skill in "coloring up" Flamingoes, that these birds were sent to him from all parts of Europe. By some change in food, a secret known only to himself, he was enabled in a short time to restore them to full color. Yet in a short time the new color was lost and the original faded aspect resumed. Prof. C. V. Riley cited numerous instances of the distribution of insects similar to that of the meaoow larks. Dr. Gill called attention to similar cases with fishes. (It may be well to note here similar parallel cases in the plant world. *Clematis viorna* is a well-known, widely distributed plant of eastern North America, extending, however, only as far west as Kansas, where it is not common. *C. pitcheri,* classed by some as a variety of Viorna, is a western form found nowhere east of the lower Wabash valley in Indiana, but extending westward through Missouri, Arkansas and Texas. It is extremely probable that the two forms owe their distribution to the same cause or causes as the two forms of meadow lark above referred to. Some species of Verno-

nia (Ironweed) seem in similar positions. Four of the species are exclusively trans-Mississippi. One oversteps the boundary into west Tennessee. Two others, on the contrary, are eastern and central species which overlap the others by extending into Iowa and Kansas. It is further interesting to find certain hybrids between the eastern and the western forms, which, if they came from the debatable ground of Iowa, Missouri and Kansas, would furnish additional interest to the problem.

Another paper read at the same meeting was by Prof. Riley, upon the English sparrow. Examination of the stomachs of more than five hundred specimens showed that only from fifteen to seventeen per cent of the whole number contained any insect remains at all. The rest contained grains or seeds of various sorts, straw and gravel. The insects found belonged to all orders, and were generally such as are either harmless to the agriculturalist or even actually beneficial. The stomach of a single specimen of a truly insectivorous bird contained two hundred and fifty web worms. Such a bird would do more good in ridding trees of various insects than all of the eighty-two sparrows in whose stomachs insect remains were found. Investigations of a similar nature carried on by Mr. Charles Dury, of Cincinnati, lead to a similar conclusion, that the value of the English sparrow as an insect destroyer is nothing compared to that of a truly insectivorous bird, and that it is injurious rather than beneficial.—*Jos. P. James.*

Brocas Convolution in the Apes.—Dr. Hervé in the *Bulletin de la Société d'Anthrpologie de France* (April, 1888), discusses the disputed question as to the development of the third (Brocas) frontal convolution in the monkeys. After an examination of the homologies of the fissures presented by that region of the brain, he finds that it is wanting or extremely rudimental in the Quadrumana, while it is present in the Anthropomorpha, though smaller in the apes (Simiidæ) than in man. This is interesting, as it confirms the evidence from the osteology, that the apes and man form a natural group, distinct from the monkeys and lemurs. It also points to the possibility of teaching some of the apes to speak, and also to the probable gradual acquisition of this important characteristic of man.—*E. D. Cope.*

Zoological News: Protozoa.—In the *Zoologischer Anzeiger* (No. 286), G. Cattaneo called attention to the existence of a parasitic ciliate infusorian (*Anophrys maggi*) in the blood of the crab, *Carcinus mœnas.* In the same Journal (No. 292) Géza Entz describes the occurrence of another Ciliate (*Nyctotherus cardiformis*) in the blood of *Apus cancriformis.*

Rupert Valentin records the presence (*Zool. Anz.*, 292) often in comparatively large numbers of psorosperm masses in the tissues of two species of Lucernaria. In each mass the spores were in various stages of development.

Franz Leydig also calls attention to the fact that in 1860 he described parasites in the blood of Daphnia, Lyncius and Cyclops, and complains that he also called attention in his Natural History of the Daphnidæ to their existence in the blood and other tissues of sick silkworms, a fact which has been overlooked by all subsequent students of the diseases of the silkworm.

Dr. Stokes describes a number of North American Flagellata in *Jour., of the Royal Microscopical Society* for October. The forms are *Mastigamœba flexuosa, Cercomonas truncata, C. heterofilum, C. lapsa, C. undulans, C. mutabilis, Heteromita granulifera, H. tremula, H. stagnalis, H. sphagni, H. nasuta, H. parvifilum, Tetramitus frondarius, Hexamita truncata, Atractonema pusilla, Hymenomonas flava, H. fusiformis, Zygoselmis obovata, Stereomonas parvula, Anisonema obliqua, Hymenona* (nov. gen.), *sphagni*, and *Petalomonas orbicularis.* There is no definite locality assigned to any of the species.

Mr. C. D. Sherborn has recently published in London a volume of 152 pages, devoted exclusively to a bibliography of the Foraminifera, recent and fossil.

SPONGES.—Wierzijski (*Verhandl. k. k. zool-bot. Gesellsch.*, Wien, 1888) thinks that all the so-called species of Euspongilla are but one in reality, the differences being the result of environment. He also found near Lunberg a sponge which he regarded as closely allied to Pott's *Spongilla terrœnovœ*, but afterward concluded that both his form and the Newfoundland species were deformed individuals of *Myenia mülleri.*

CŒLENTERATES.—Vogt thinks that Arachnactis is not, as the younger Agassiz thought, the young of the Edwardsia but a distinct genus allied to Cerianthus and like the latter retaining its distinctly bilateral character throughout life. Though he does not expressly say so, Vogt is apparently ready to adopt the view that in the Hydrozoa as in the Anthozoa the free-swimming form is the primary and the attached condition secondary and adaptive.

WORMS.—O. Zacharias records (*Biol. Centralblatt*, VIII., p. 542) the occurrence of a land planarian (*Geodesmus terrestris*) between the gills of the mushroom (*Agaricus deliciosus*).

About two years ago we referred to the account given by Dr. Walker, of Buffalo, concerning the life history of the tape worm of

fowls. He claimed that the intermediate host of the worm Syngamus was to be found in the earthworm. Recently (*Nature*, XXXVIII., p. 324) Lord Walsingham gives facts collected from the experience of sportsmen which tend to corroborate this view. In dry summers when but few earthworms come to the surface, game fowl are comparatively free from the disease, but when worms are abundant, the fowl are more difficult to rear.

G. Brandes, in a preliminary communication embodying his anatomical discoveries, points out that the Trematode H*olostomum* has been regarded wrong side up, the "ventral" surface of authors being really dorsal and that the "larval anus" of the Tetracotyle stage of the worm is but the beginning of a gland and its duct, the alimentary canal ending blindly in the body parenchyma.

Dr. J. W. Fewkes describes and figures (*The Microscope*, 1888) a new type of marine larva found in the Bay of Fundy, and in Massachusetts Bay, which is regarded as having brachiopod, chætopod, and bryozoan features, but which seems to be nearest Mitraria in its affinities. The adult to which it belongs is unknown. Fewkes, in conclusion, has some remarks upon the characters of the common ancestor of Polyzoa, Brachiopoda, and Chætopoda, which lead him to suggest as a name for this hypothetical form "that of Mitraria, which up to the present is applied simply to the larval form of a single genus of Chætopoda."

Iijima and Nusata record some new cases of the occurrence of *Bothriocephalus liguloides* in Vol. II. of the *Journal of Science* of the University of Tokio.

MOLLUSCA.—Some sixty years ago Desmarest and Lesueur proposed to issue a series of illustrations of Polyzoa and Hydrozoa, and fourteen plates were engraved on copper by the latter. A few of the plates were distributed, but no accompanying text was ever prepared. Recently E. Pergens (*Procès-Verbal de la Soc. Roy. Malacol. Belg.*, Sept., 1887) has examined the original manuscripts and the types preserved in Havre, and has given identifications of the Polyzoa there figured.

PROTOZOA.—The Martini-Chemnitz "Conchylien-Cabinet" still appears at intervals. Numbers 356 to 361 have recently appeared, containing plates of Cardita, Pecten, Spondylus, Cerithiidæ, Chama, Cardita, Solen, and Modiola.

Paul Pelseueer denies (*Bull. Scientif. France et Belgique*) the existence of a group of Orthoneurous Gastropoda.

CRUSTACEA.—According to the *Journal of the Royal Microscopical Society*, D. Bergendal has described the occurrence of distinctly male copulatory appendages on female crabs. In many cases there

were no appendages on the first segment of the abdomen; in others spoon shaped; in a few like those of the male. Only the useless and normally rudimentary first pair of appendages show this modification, the second pair which are functional are never modified in this way.

TUNICATA.—Prof. Herdman, in the *Proceedings of the Biological Society of Liverpool* (1887, p. 24), thinks that recent investigations tend to establish that the pineal gland and the pituitary body of the Vertebrata, are both of them the remains of organs which reached the surface of the head in the ancestral Chordata, the pineal in the form of a median dorsal organ of sight; the pituitary possibly also as a sense organ placed on the front of the head close to the mouth opening.

BIRDS.—Dr. R. W. Shufeldt contributes to the *Auk* (Vol. V., Oct., 1888) figures of the skulls of *Habia melanocephala* and *Pipilo megalonyx*, from which he shows that the grosbeaks are possessed of skeletal characters not shared by any other fringilline birds, and are possibly entitled to family rank.

Mr. N. S. Goss, of Topeka, Kansas, wishes information concerning the western range of *Anas obscura*, the black duck. He is inclined to doubt its occurrence west of the Mississippi, all the specimens which he has examined proving to be the Florida duck.

MAMMALS.— At the meeting of the Linnean Society of New South Wales, Aug. 29th, 1888, Professor Tate exhibited a salted and sun-dried mammal from Alice Springs, Central Australia. In general appearance the animal resembled a Cape Mole (Chrysochloris). Its teeth and limbs indicated an insect diet and a burrowing life. Though no marsupial bones were seen on cursory examination, the marsupial character was shown by marginal folds bordering the lactiferous area, which also, together with some other points, indicated affinity to the Monotremes as well. The dentition is said to resemble that of the purassic genera. According to the natives it was the second specimen seen for sixteen years. A full description will be given later by Mr. Zietz, of the South Australian Museum.

ENTOMOLOGY.[1]

ON THE METHODS OF EXPERIMENTS IN ECONOMIC ENTOMOLOGY.[2]—The establishment by the United States Government of an agricultural experiment station in connection with each of the state Agricultural Colleges has resulted in a great increase of attention to experiments in economic entomology. This increased attention has brought clearly to light the inadequacy of the methods commonly employed in experiments in this field. In fact the state of entomological science is such that he who wishes to conduct careful experiments, except in a few simple lines, is first forced to develop the methods of investigation.

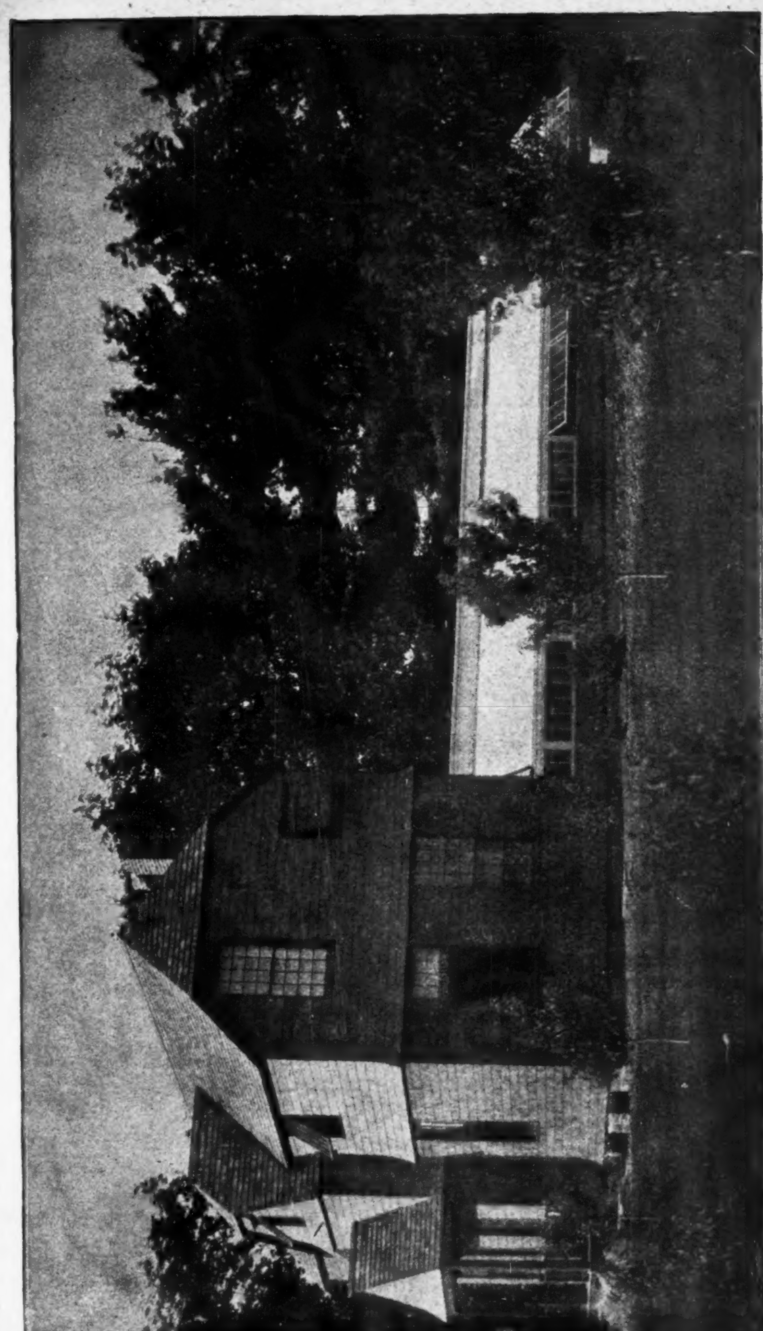
Although there are many entomologists engaged in research, and although the literature of the subject is a vast one, more than a score of journals being exclusively devoted to this specialty, comparatively little is done in the study of the transformations and habits of insects, or in making practical applications of entomology. With the exception of a few government entomologists, the energies of the workers in this field are almost entirely devoted to the description of species. And although a few workers have achieved very important results in the study of the habits of insects, and in making practical applications of the facts observed, they have done this with very crude apparatus, and often by methods which cannot be relied upon to give exact results. While magnificently equipped laboratories of physiology and histology are springing up at all of the scientific centres, the student of the habits of insects contents himself with a few breeding cages scarcely better than those used by Réaumur a century and a half ago.

An illustration of the imperfection of the methods commonly employed is the fact that experiments with insecticides are usually conducted only in the field, where the conditions cannot be controlled. I have before me a report of an experiment made to test the efficiency of a certain substance as an insecticide. The insects experimented upon were root-feeding larvæ. A careful examination of the field made at the close of the experiment revealed five times as many larvæ upon the roots of the plants treated with the supposed insecticide as there were upon an equal number of plants that had not been treated. It is evident that the application had no effect as an insecticide. But would this conclusion have been so evident had the Experimenter happened to have treated the

[1] This department is edited by Professor J. H. Comstock, Cornell University, Ithaca, N. Y., to whom communications, books for notice, etc., should be sent.

[2] Partly from the advance sheets of the Report of the Cornell University Experiment Station for 1888.

PLATE XXIX. 1128



THE CORNELL INSECTARY.

second lot of plants instead of the first? Would it not have appeared that four-fifths of the insects had been destroyed?

While it is evident that ultimately we must depend upon field experiments for demonstrating the value of methods of preventing the ravages of insects, the danger of error in such experiments is so great that it is unwise to depend upon them in working out principles upon which such methods are based. Obviously the worker in applied entomology needs a laboratory and apparatus as much as does the chemist or physiologist; and this laboratory should be different from our ordinary entomological laboratories.

The greater number of subjects which a worker in this field should investigate fall under two heads: first, studies in the life-histories of insects: second, experiments in the destruction of noxious insects or of preventing their ravages. Work in neither of these lines can be well done in an ordinary entomological laboratory. In order to make accurate investigations of this kind it is necessary that there should be a place where living plants can be kept with insects upon them, and that all of the conditions of growth of both plants and insects should be under control.

We have already given an account (*Ante*, p. 468) of the Laboratory of Experimental Entomology at Cornell University. A view of the exterior of this building is now furnished our readers. Plate XXIX.

Soon after the erection of this laboratory we found that it was desirable to designate it by a name which should distinguish it from the entomological laboratory of the University where instruction is given. As this, so far as we know, is the first building of its kind, we were forced to coin a word; and have proposed the name *Insectary* for buildings arranged for keeping or raising living insects.

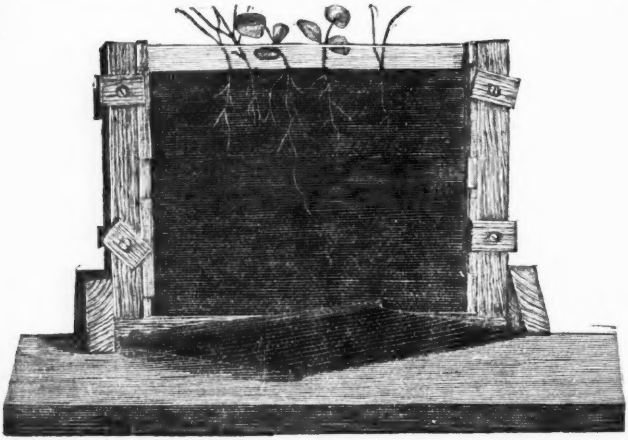
We hope that the time is near when the need of an Insectary for entomological work will be as fully appreciated as is the necessity for a propagating house for the horticulturist or a conservatory for the botanist.

But the building is not all the equipment required for the entomological work of the future. We need specially constructed apparatus for this work. The breeding-cages and the methods of observation and preservation of specimens which we have inherited from the last century will not meet all the requirements of the complicated problems we have to solve. There must be more accurate methods of observing the habits and transformation of insects, more perfect ways of testing insecticides, and better means of preserving specimens for study. It is not too much to hope that the methods of entomology of the year 1900 will be as much in advance of those of to-day, as the present methods of histology are in advance of those of fifteen years ago.

With the hope of stimulating the study of methods, I present

below descriptions of a few simple devices which I have found of much use in my entomological work.

The most important of these is a device for observing subterranean insects. This device I have termed a root-cage. It consists of a frame holding two plates of glass in a vertical position, and



only a short distance apart. The space between the plates of glass is filled with soil in which seeds are planted or small plants set. The width of the space between the plates of glass depends on the width of two strips of wood placed between them, one at each end, and can be varied according to the necessity of each experiment. Outside of each glass there is also at each end a strip of wood for holding the glass in place. The strips are fastened by means of wedges forced between them and buttons projecting beyond the edges of the end pieces, as shown in the figure. It is necessary to have wedges upon only one face of the cage. By making the three strips of wood at each end of the cage (one between the glasses and one outside of each), of different widths and interchangeable, the width of the space between the glasses can be easily varied. Immediately outside of each glass there is a piece of blackened zinc which slips into grooves in the strips at the ends, and which can be easily removed. When these zincs are in place they keep the soil dark. In the first lot of root-cages that I had made holes were bored in the bottom to provide for drainage. But the danger of the escape of insects through these holes has led me to depend on the leakage of the water through the cracks between the glass and the wood. A layer of very coarse sand one inch in depth at the bottom of the space between the glass facilitates drainage.

If the space between the two plates of glass be very narrow, when the seeds which have been sown in this cage germinate, a large part of the roots will ramify in the soil so near the surface of the glass that they may be easily seen by simply removing the piece of zinc already described. When the plants have become well established they may be infected with the insect pest to be studied, and continuous observations can be made without disturbing them. Thus at the present time I have corn growing in these cages with wire-worms feeding upon its roots. In other cages I have clover growing, the roots of which form an almost continuous mat on the inner surface of the cage. Better results can be obtained in this way than by going into the fields and digging up plants; for in most cases the moment plants are dug up the insects stop their work, while in these root-cages continuous observation of the same insect is possible.

I have had constructed several large root-cages, the frames of which are of iron, and each side of which consists of eight lights of glass, each ten inches by twelve inches in size. A pit has been dug for the reception of each cage; these pits are walled with brick. When the cage is placed in the pit, the top of it is even with the surface of the ground; by excluding the light from this pit it is hoped that the roots can be kept under nearly normal condition. These cages have been constructed for larger plants; thus we purpose to plant apple-trees in some, for the study of the root form of the Woolly Aphis of the apple; grape-vines in others in order to observe the Grape Phylloxera; and hop-vines in still others for use in proposed experiments upon the Hop Plant-louse. These cages are lifted from the ground when it is desired to study them by means of a small portable derrick.

Another form of breeding-cage which I have found very useful is made by combining an open-top bell-jar and a flower-pot. The food plant of the insect is either growing in the pot or is stuck into wet sand in the pot and kept fresh as a gardener would keep a cutting. A large saucer is used, and an inch or more of sand is placed in it. The bell-jar is placed over the plant in the pot and pressed down into the sand in the saucer. The open top of the bell-jar is covered with swiss muslin. The plant or cutting can be kept well watered by pouring water into the saucer without removing the bell-jar. The layer of sand in the saucer saves from drowning those insects that crawl down from the plants. The circulation of air through the muslin at the top prevents the formation of mould.

I have long used jelly-tumblers and fruit-jars for breeding small insects and for storing pupæ. I have been much annoyed by inability to preserve the proper degree of moisture in these receptacles If they are supplied with moistened sand and closed tightly the

specimens soon mould; if covered by muslin the sand in a short time becomes too dry and the specimens, if they emerge at all, are apt to do so in a crippled condition. I have obviated these difficulties by boring a hole in the bottom of the jelly-glass or fruit-jar and setting it in a flower-pot saucer. By pouring a little water into the saucer from time to time, the sand in the jar can be kept moistened and the excessive wetting caused by pouring water upon the sand avoided. The holes in the glass are bored by means of the end of a broken rat-tail file wet with turpentine.

Other forms of new apparatus are in use, but they are not sufficiently perfected to warrant description at this time.—*John Henry Comstock.*

EMBRYOLOGY.[1]

Development of the Peripheral Nervous System of Vertebrates.—Dr. Beard[2] continues his important studies on this subject, which is just now interesting some of the most distinguished of living students of the general ontogeny of the vertebrates. His results as to the origin of the ganglia of the posterior sensory roots of the spinal nerves, and of the sympathetic system, are startling and unexpected. His discoveries may also be ranked as fundamental, and amongst the greatest of recent times, as regards their consequences. The following résumé of his conclusions is given in his own words:—

"The spinal ganglia of vertebrates are formed as differentiations of the inner layers of the epiblast just outside the limits of the neural plate. As the result of the cutting out from the epiblast of these ganglionic elements an appearance is presented by the epiblast which is left, to which Professor His gave the name of 'Zwischenstrang.' This has no share in the formation of the ganglia. The 'Zwischenrisme' of His has no existence, but certain portions of the cranial ganglia, called here neural ganglia, are developed from the epiblast before closure of the neural tube, *in exactly the same way as the spinal ganglia.* These portions of cranial ganglia are more or less homologous with spinal ganglia, possibly only with the sympathetic portion of the spinal ganglia 'Anlagen.' After separation from the epiblast, the neural cranial ganglia and the

[1] Edited by Prof. Jno. A. Ryder, Univ. of Penna., Philadelphia.

[2] Morphological Studies, II. The development of the peripheral nervous system of vertebrates, Part I., Elasmobranchs and Aves, Quar. Journ. Mic. Science, xxix., pt. ii., 1888, pp. 153-227, pls. xvi.-xxi. By J. Beard, Ph.D., B.Sc.

spinal ganglia get carried up with the closing in of the neural tube, and come to lie between its lips, but are quite distinct from the central nervous system, and the line of boundary between the two can always be distinguished. After the closure of the epiblastic folds the 'Anlagen' grow out of their position between the lips of the neural tube, and acquire their first and only connection with it by the probable growth of fibres from the ganglia into the central nervous system. The neural cranial ganglia also grow towards the lateral epiblast at the level of the notochord, and fuse with it. Here are the Anlagen of the lateral or branchial sense organs of Froriep and myself. From this fusion in all vertebrates form-elements pass into the cranial ganglia; these form-elements I distinguish as lateral ganglia. The parapodial ganglia of Annelids appear to be homologous with the spinal ganglia of vertebrates, as Kleinenberg suggested, and also more or less with the neural cranial ganglia.

"The anterior roots of cranial and spinal nerves arise as outgrowths of ganglia situate in the central nervous system. To form them, cells leave the nervous system and are distributed in the nerve. All the anterior roots at first contain many nuclei, which are of nervous and not parablastic origin. These statements on the anterior roots are only a confirmation of Balfour's researches.

"In addition to the four elements of the anterior and posterior roots, two ganglionated and sensory, two motor and unganglionated, distinguished by Gaskell, Hill, and partially by His, the cranial nerves contain a fifth element, derived from the lateral or branchial sense organs. Such are, in very brief form, the main results of the researches recorded in the preceding paper."

Dr. Beard shows that the so-called "neural ridge" of Balfour is developed from a portion of the epiblast hitherto overlooked by embryologists, and extending along either side of the medullary plate, and that it precedes by a very considerable interval of time the appearance of the "neural ridge" to which it gives rise and from which the spinal and sympathetic or neural ganglia are subsequently developed.

Further observations have been communicated by Dr. Beard to the *Anatomischer Anzeiger*, III., No. 29, 1888, pp. 875–884 (to be continued in No. 30) on this same subject. His completed results will be published in three parts: Part I., discussing the development of the peripheral nerves in Elasmobranchs and Birds; Part II., Frog, Triton and Lacerta; Part III., Mammalia. Of these, only Part I. has yet appeared in the journal cited below in full.

It is stated in the conclusion of the first part of the article in the *Anatomischer Anzeiger* (p. 884), "It can be proved embryologically that of the following cranial ganglia each and every one is made up of two parts, a neural part and a lateral part, which are devel-

oped respectively from the sources mentioned above, Olfactory ganglion, mesocephalic, trigeminus, facial, auditory, glossopharyngens, and vagus complex." In a foot-note it is stated, "I hope soon to show that the end-organs of taste arise from such thickenings [of the sensory epithelium] which have wandered through certain gill-clefts into the buccal cavity" (*Anat. Anz.*, p. 879).

A NEW ATLAS OF EMBRYOLOGY.—Nothing to compare with the splendid atlases of Coste on Comparative Embryology, and of His on the human embryo, has yet been published on the Chick. This desideratum will be met by the *Atlas d'Embryologie*, by Mathias Duval, just announced by G. Masson, Paris. The author has done wisely in keeping it in quarto form, and with forty plates, embracing 652 figures, it will cover the history of bird development very fairly. The first plate gives views of the egg in the ovary and oviduct, and the chick in the egg nearly ready to hatch, in short, a "vue d'ensemble de sujèt." The next two plates are devoted to the structure of the egg, segmentation and formation of the blastoderm. Plates IV. to X. show surface views of the blastoderm and embryo at successive stages. Plates XI. to XL. are devoted to representing sections of the successive stages shown entire on Plates IV. to X. Facts only are presented, theoretical considerations being left to the student after he has mastered the data. The whole is provided with a copious index, and also contains an account of the necessary embryological technique involved in a study of the development of the chick. The reviewer predicts that Professor Duval's work will be welcomed by teachers as a very useful help in the practical study of the subject in the laboratory. The book will be useful for reference to supplement other manuals, and, as it seems to the writer, a thorough knowledge of the embryology of the chick will best serve as an introduction to the wider field of comparative embryology. The appearance of this atlas is timely, for it is probable that eventually embryology will have to be taught in order to enable the beginner in morphology to understand the significance and relative importance of the data of advanced morphology in general.

In taking a survey of the field of embryology, as covered by the existing literature, one is struck by the fact that, in spite of the great activity of the individual workers, but few really exhaustive monographs provided with adequate atlases are in existence. Such beautiful embryological monographs as Goette's on Bombinator, of Reichenbach on the Cray-fish, are lasting contributions to science; the works of Selenka and Whitman, too, and, amongst the productions of the older workers, the great monographs of Von Baer, Rathke and Bischoff, must ever command admiration. Complete

as some of these are, we are still deplorably deficient in monographies which serve to illustrate the later or post-embryonic changes, intervening between the last stages with which the embryologist cares to concern himself, and the point where the organism becomes adult, when it is supposed that the scalpel of the anatomist is all-sufficient in prosecuting farther inquiry. This is unfortunate, since the details of the final metamorphosis of whole systems of organs, even in animals as thoroughly studied as the chick, is in some cases scarcely at all known, or so imperfectly as to be nearly the same as if altogether unknown. The external features of the development of the skeleton of the chick are pretty well known, but the internal and histological changes, and the development of pneumaticity of the bones, quite imperfectly.

Now that serial sections may be so easily prepared and photographed upon an enlarged scale, it is strange that no one has yet undertaken to prepare sets of uniformly enlarged photographs of series of sections, arranged in a folio in the order in which they were cut, of the most important stages of the development of the chick, and thus supply a more satisfactory iconography of the embryology of this animal than we yet possess. Series of enlarged photographs of serial sections, arranged as suggested, if made with care, would serve almost as well for purposes of reconstruction as the modelling method of Born, or the method of graphic isolation proposed by Kastschenko. It would, in fact, make it possible to inspect series of sections of an organism with as much readiness and as minutely as one is enabled to inspect the successive pages of a book. In fact, the topography or relations of the organs, as well as some notion of their histological composition, in an embryo, in successive planes, could be as readily got at in this way as the text imprinted upon the pages of a book. If thin gelatine positives of such series were properly prepared, protected, and arranged in their proper serial order, in the form of a roll, series of sections could be projected, one section after the other in succession, upon a screen for purposes of lecture demonstration, in a manner far more effective than would be possible with the most complete serial sets of diagrams.—*J. A. R.*

ARCHÆOLOGY AND ANTHROPOLOGY.[1]

ANTHROPOLOGICAL SOCIETY OF WASHINGTON.—Prof. O. T. Mason, of the National Museum, read an interesting lecture on the subject of "the Human Beast of Burden." He viewed the subject from an anthropologic standpoint. He began with transportation and commerce in prehistoric times. Men and women were the first beasts of burden, and all aboriginal carrying was done on their heads and backs. Even the improved state of civilized society has not extinguished all traces of this, for human carriers are still numerous. Hod-carriers have been but recently, and, indeed, partially, superseded by elevating machines. The great progress of the time has been such, continued Prof. Mason, that no one walks nowadays, unless it is a preferred exercise; horses, steam and electricity lend their aid to whirl people to their destinations.

He enumerated the various methods by which the human beasts of burden perform their carrying tasks. First by hand, the right hand. He said he had examined a great number of savage implements designed to be carried in the hand, and that the proportion of those shaped for use by the left hand was not greater than 1 to 50; in no case did he find a left-hand female implement. Then both hands are used, after which the fingers come into play. Illustrating the use of the fingers in carrying he mentioned the summer-resort waiter, who bears his tray aloft on three fingers. The baldric is next in order, slung over the shoulder by a strap and hanging on the hip. In this way hunters carry game and travellers carry small satchels. Then, still progressing, goods to be carried are to be hung to a belt. Hanging things on the arm may be called the retail method of carrying, and is used by farm hands, servants, porters, in fact a large proportion of the people we meet in any place. While a civilized being will twist his form so as to get the load that is hung on his arm supported by his back, a savage will never be found doing so. Next comes the hanging over the shoulder. This method is used by grain porters and hod-carriers.

The oriental porters carry almost exclusively on their shoulders. A coolie's average load is 100 pounds, with which he will make 30 miles a day. It is estimated that there are 1,000,000 tons of material moved by coolies in China each day. Then both shoulders come into use, the load being placed around the necks, after which an easy progression is to the back, which is the natural carrying-place of the burden. The soldier carrying his knapsack and rations, is a good example. Then loads are carried on the head, a

[1] This department is edited by Thomas Wilson, Esq., Smithsonian Institution, Washington, D. C.

process called "toting." The negro as a domestic example, and the dairymaid, are reputed to carry their milk pails on their heads, and there are many other illustrations of this mode of transportation. Certain tribes of Indians wear straw rings on their heads to aid in bearing and balancing these great loads. Pockets, remarked Prof. Mason, are scarcely worth mentioning as a civilized means of transportation, although the flowing robes of a Chinaman are capable of concealing at least half a bushel of playing cards, a capacity that deserves passing notice. The carrying power given by these various modes is augmented by means of combinations of men, in illustration of which the vast works in Egypt and other eastern countries were cited. Men also carry goods by traction, that is, by drawing over the ground. First, the arm alone is used, then a line is fastened to the object and the person. It is held in the hand over the shoulder, wound around the waist or over a pole. The hunter drawing home his game is a primitive example of this means of carrying. Throwing is sometimes resorted to as a means of transportation, of which the method of handling bricks by tossing them from hand to hand is a fair sample. Dirt and excavated material were at first carried in sacks, which have been superseded by shovels. The great necessities and the differentiating progresses of civilization for rapid and safe transportation give rise to the professional carriers.

THE FIFTH ANNUAL REPORT OF THE BUREAU OF ETHNOLOGY.—This Volume for 1883–'84 has just appeared. It contains about 600 pages in quarto form, the report of the Director, Major J. W. Powell, filling about 50 pages. The accompanying papers are as follows:—

One on Burial Mounds in the northern section of the United States, by Prof. Thomas. He describes the burial mounds of the Wisconsin district, of Illinois or upper Mississippi, of Ohio, and of the Appalachian district, and elaborates the favorite theory of the Bureau of Ethnology, that the Cherokee Indians were the principal mound-builders of the United States. He reports the discovery made by the exploration of the great and small Etowah mounds in Bartow county, Georgia, and many of the objects found therein are shown by means of illustrations.

Chas. C. Boyce, Esq., gives the history of the treaties made between the United States and the Cherokees. He gives the material provisions of all treaties made, together with their historical data, from that of November 28, 1785 to April 27, 1868. His paper is quite full and seems to have exhausted the subject. It fills 250 pages.

Dr. Washington Matthews, of the United States Medical Museum, furnishes the Mountain Chant, a ceremony belonging to the Nava-

jos. This is a comparatively new field for anthropological research, and Dr. Matthews has been the principal husbandman. His paper is deserving of high encomium. It is beautifully illustrated, and shows the author to be as equally successful as a poet and historian, as he has been in anthropology and medicine.

Rev. Clay MacCauley devotes fifty pages to the Seminole Indians of Florida. He describes their personal characteristics, physique, costumes, and personal adornment; their society and tribal life, their industries, arts, and religion, and makes a valuable contribution.

Colonel James R. Stevenson might have been well denominated the soul ol the Bureau of Ethnology. He was the discoverer of its protoplasm, and was its Executive officer during the greater part of its existence, until his death in August, 1888, at the Gilsey House, New York City. This is no place for panegyric upon his abilities. Whatever of honor and credit, history shall mete out to him for his anthropologic researches among the Zunis and other Indians of the interior and western United States, must be fairly divided with his wife. She accompanied him in all, or nearly all, his explorations, and her zeal, ability, faithfulness and address in procuring the more difficult secret information concerning the inner life of Indians and Indian women, of their mythology, of their religious societies, of the ceremonies by which they were carried on, can never be fully portrayed or thoroughly understood. His contribution to the present volume is the "Religious Life of the Zuñi Child." Her paper is illustrated by four full-page chromo-lithographic plates, illustrative of the masks, dresses, and other objects used in the ceremonies which she describes.

Some Superstitions of the Bahama Negroes.—Some years ago, while in the employment of the Bahamas Government, I spent a month in exploring the island, or rather islands, of Andros, in the west of the Bahama archipelago. The negroes of the northern part of Andros are physically the finest in the colony, and are also superior in other ways, in spite of their bad repute in Nassau. It is said that during the Indian wars in Florida numbers of Indians made Andros their temporary home, but they appear to have mixed very little with the negroes. One old man, however, who was my host during my stay in the island, says that his grandfather was an Indian, and his appearance bears out the statement to some extent, his color being of a reddish brown, his features Indian in their cast, and his hair not woolly but in long curls.

The settlements in Andros are all along the East coast, the interior being a great swamp, with occasional ponds, and island-like patches of coral-rock, covered with pines, scattered throughout it. I found that many of the negroes possessed curious superstitions respecting the interior, which they rarely visited. One of my men

told me that the pine woods were inhabited by creatures called "Yayhoos" (Query, has the name come from Dean Swift?), big, black, hairy beings who walk about in "schools," the biggest first, "and if they catch you, they tear you." The only way of putting these creatures to flight was by waving a torch at them. There were also small, black beings like little men, who were called "little people," who lived in the branches of the pines, and if one pointed a finger at them, one fell down a cripple. These had been seen by the father (of course, dead) of my informant. These superstitions would appear to relate to the gorillas and monkeys of the West Coast of Africa, and to have been handed down from the original African slaves to their children. The pine woods were also said to be inhabited by "mermaids" of both sexes, the name being used indiscriminately, who occupied themselves in the traditional way combing their hair.

An eerie story was told me by my old host. Once, in his father's time at one of the southern settlements, a woman left two of her children at home while she went to the fields. On her return, she found that the younger, a mere infant, had disappeared, and that the elder could not say what had become of it. The well was searched, and parties of men hunted through the bush, but for some time without result. On the third day, however, some of the men heard cries, and forming a ring they gradually reached the spot whence the cries came. There they saw an awful sight; the missing child was held by a *thing* without head or arms or legs, and more like one of the great, brown ants' nests than anything else. When it saw the men, the thing appeared to be afraid, and threw the child on to a mass of "love-vine," trailing from a neighboring tree, and then made off into the bush. The men, horribly frightened, took to their heels, except one, who took up the child from the ground to which it had fallen, and carried it home. The child's body had become like jelly, and it only lived a day or two. This story appears to be "made out of whole cloth," and the conception of an ant's nest, headless, eyeless, limbless, yet capable of seeing, moving, throwing, is grotesque even for a negro imagination.

The negroes of the Bahamas show far fewer effects of white influence than those of the United States, or even of the other West India Islands. Even in New Providence they have customs which, I fancy, are not found in the South, such as the fire-dances, the election with great ceremony of queens of the Congo, Yuruba, and Ebo tribes, etc. A belief in Obeah is prevalent, and probably also Voodooism, but it is excessively difficult for a white man to obtain any information on the matter, in New Providence, at least. In Andros there might be fewer difficulties in the way, for the confidence of the negroes there is easily won, if they be well treated.

MICROSCOPY.[1]

THE PROCESS OF STAINING SECTIONS SIMPLIFIED BY MIXING THE STAINING FLUIDS WITH TURPENTINE.—According to Dr. Kükenthal's experiments, a large number of coloring substances admit of being mixed with turpentine, and serial sections may be stained in a short time by such a combination. Methyl-green, methyl-blue, gentian-violet, safranin, Bismarck-brown, eosin, fuchsin, tropæolin, and malachite-green may be used in this way.

The dry coloring substance is dissolved in *absolute* alcohol, and the solution dropped into turpentine until the mixture has any intensity of color desired.

Meyer's[2] Carmine Solution.

Absolute alcohol	100 cc.
Pulverized carmine	3 gr.
Hydrochloric acid (neutralized with ammonia)	25 drops

Can be united with a mixture of turpentine and absolute alcohol [in equal parts?], and in this form used for staining sections.

The method of using these stains is very simple. The sections are fastened to the slide by Schällibaum's collodion, then left in the oven of the water-bath until the clove oil has been completely driven off. The paraffine is next removed by washing in turpentine, and then the slide is immersed in the staining mixture. As soon as the desired depth of stain has been received, the sections may be washed in pure turpentine and mounted in balsam.

If the stain is too deep, or a sharp nuclear stain is desired, it is only necessary to leave the slide a short time in a mixture of turpentine and pure (free from any trace of acid) absolute alcohol, and the color will be reduced.

The coloring mixture may become cloudy, as the result of the evaporation of the alcohol; in such an event, the addition of a drop or two of alcohol generally suffices to clear the mixture.

This method enables one to use easily several stains in succession. Objects may also be colored, *in toto*, with the advantage that the process of staining can be followed and easily controlled.

Fixing and Preserving Histological Preparations.—Dr. N. Kultschitzky[3] discusses the merits and defects of the principal reagents employed in "fixing" and preserving histological preparations,

[1] Edited by C. O. Whitman, Director of the Lake Laboratory, Milwaukee.

[2] The carmine is boiled in the alcohol, and then the acid added. The solution is then filtered, hot, and enough ammonia added to neutralize. After filtering again the solution is mixed with turpentine and absolute alcohol.

[3] Zeitschr. f. wiss. Mikroskopie, iv., 3, p. 345, 1887.

points out the requirements to be fulfilled by such reagents, lays down the principles by which one should be guided in selecting them, and concludes by giving a method which has proved to be eminently satisfactory.

Rules.—(a) For fixing tissues it is important to use reagents that do not form tissue-like precipitates with protoplasm. This requirement is met by *chromic salts, sulphate of copper, sublimate* and some other salts. *Preparations in chromic salts, when transferred to alcohol, should be kept in absolute darkness* (H. Virchow), until the fixing reagent is removed so far as possible.

(b) All reagents which transform protoplasm into tissue-like forms, as, *e.g.*, chromic acid, should be avoided, or their application must be controlled.

(c) Fixing fluids should contain an organic acid, *e.g.*, acetic acid, which changes nuclein into an insoluble state. The acid must be used in a diluted form, as nuclein is dissolved in strong acids.

The time of action must be short, as the long-continued action of even a weak acid dissolves nuclein.

(d) It is desirable that the fixing fluid should contain alcohol in a small quantity.

Strong alcohol dehydrates and induces changes in the protoplasm.

Kultschitzky's Fluid.—Add, *ad libitum*, pulverized bichromate of potassium and sulphate of copper to alcohol (50 per cent.). Keep in absolute darkness twenty-four hours. A transparent greenish-yellow fluid is thus obtained, which is to be acidulated before use with acetic acid (5 to 6 drops to 100 cc.).

Method.—Place the object in the fixing fluid for from twelve to twenty-four hours, according to its size and hardness, and keep in the dark; then transfer to strong alcohol. After twelve to twenty-four hours the preparation is hard enough for cutting.

Conservation.—Kultschitzky thinks that for conservation only such fluids should be used as produce no further changes in protoplasm after it has once been fixed. As alcohol, Müller's Fluid and other fluids in common use do work changes in the tissues, Kultschitzky recommends keeping preparations in ether, xylol, or toluol.

Accessory Nuclei (Nebenkerne, Paranuclei).—Dr. Gustav Platner[1] has been for some years engaged with the problem of the origin and meaning of accessory nuclei in gland-cells. The results of his work have not yet been published, so far as I am aware; but some of his methods of study have been given in the *Zeitschrift für wissenschaftliche Mikroskopie*, Vol. IV., No. 3, p. 349. Flemming's *chrom-osmio-acetic acid* is the best hardening, or "fixing" medium. This mixture may sometimes be modified to advantage by diminishing the quantity of acetic acid and increasing that of osmic acid. When the accessory nucleus forms a compact mass, as in reptiles

and many anura, a mixture of picric acid and sublimate gives good preparations.

A New Staining Fluid.—Finding that hæmatoxylin varied considerably in its effects, according to the age of the solution, or the method of hardening employed, Dr. Platner looked for another staining substance that would better meet his needs. The search led to the introduction of a new stain, for which Platner suggests the name "*nucleus-black.*" This coloring substance is imported from Russia, and was obtained from the chemical laboratory of Dr. Grübler, Dufourstrasse, Leipzig.

A weak solution of nucleus-black stains only nuclei, nucleoli, and axis-cylinder, leaving the cytoplasm, connective tissue, and medullary sheath uncolored. Used at its full strength it stains other tissues, but with less intensity.

An over-stain is easily reduced by dilute ammonia (five or six drops to a watch-glass full of water), or, preferably, by *carbonate of lithium*, diluted *ad libitum.* A pure and intense nuclear stain may be thus obtained. Treated in this way, the accessory nuclei are stained in varying degrees of intensity, according to the stage of their development.[1]

It is a remarkable fact that these accessory nuclei, soon after their formation, become non-receptive to *safranin* or *Victoria blue 4 R*, while remaining stainable with *nucleus-black.* It would seem, as Platner remarks, that chromatin is composed of two substances, one of which is affected only by certain nuclear stains, while the other is receptive to a large number of stains, and especially so to nucleus-black and hæmatoxylin.

Sections from preparations in Flemming's fluid may be left twenty-four hours in a dilute solution of nucleus-black. The time of exposure to the decoloring fluid will vary according to the intensity of the stain received and the end to be reached. The stain is permanent and well adapted to photographing.

The Eggs of Ascaris megalocephala.—Platner recommends heating to 50°C., for twenty to forty seconds, then hardening in ascending grades of alcohol. This method has the great advantage of killing instantly without injurious effects, and leaving the nuclear figures in a better state of preservation than can be reached by any other method hitherto used. The egg-sacks are placed in a test-tube plunged in a dish of hot water. This method will undoubtedly be useful in other cases.

[1] Accessory nuclei arise from the chromatin of the nucleus, by a process of budding, and their development may be induced by starving the animal. On the sixth or seventh day, in the case of the salamander, the formation begins, and by the end of eight or nine days one or more accessory nuclei may be found in almost every gland-cell. As soon as the cells begin again to secrete, the accessory nuclei become pale and then disappear.

Bobretzky, Hertwig, Reichenbach, and others who have employed the method of heating, have subjected the eggs to a heat of 80°C., or more, and for a considerable length of time. Platner is unquestionably right in attributing previous failures in the use of this method to the unnecessarily high temperature employed. Max Schultze has shown that protoplasm is killed and stiffened at 50°C., and the use of a nearly boiling heat is therefore quite as unnecessary as it is harmful.

PARAFFINE PREPARED FOR RIBBON-CUTTING.—Dr. Spee[2] finds that paraffine prepared in the following manner is best adapted to ribbon-cutting:—

Take paraffine, which melts at about 50°C., and melt it over a spirit lamp. Keep hot for from one to six hours, until it assumes a brownish yellow color, like that of yellow wax or honey. When cold the mass is perfectly homogeneous, and without air-bubbles. Sections, if not over $\frac{1}{100}$ mm. thick, stick firmly together in the form of a ribbon.

[2] *G. F. Spee.* Leichtes Verfahren zur Erhaltung linear geordneter, lückenloser Schnittserien mit Hülfe von Schnittbändern. Zeitschr. f. wiss. Mikroskopie, ii., 1, p. 7, 1885.

SCIENTIFIC NEWS.

—The well-known traveler and Siberian explorer, Nikolai Michalowitsch Prjewalsky, died November 1st, in Karakul.

—Mr. T. H. Potts, an ornithologist, who has done much for the exploration of the New Zealand Fauna, has recently died.

—Professor Joseph F. James, M.S., formerly of Miami University, Oxford, Ohio, should be addressed after September 10, 1888, Agricultural College, Prince George's County, Maryland.

—The Lowell Institute free courses of lectures to the teachers of Boston begin January 5th, with a course by Prof. W. O. Crosby, of the Boston Society of Natural History, upon the geology of Boston and its vicinity. The course consists of (1) a general study of the physical features of the Boston Basin, and of the geological changes now in progress; (2) a systematic study of the various minerals and rocks found in the Boston Basin, together with the more characteristic kinds of structure which they exibit; (3) a

summary of the geological history of the district so far as that is plainly recorded in the rocks, tracing the gradual evolution of the present topographic and structural features from the widely different conditions which have prevailed in the past. The object of this course is to enable the teachers of the public schools of Boston an opportunity to become acquainted with the facilities that they have at hand for the illustration of many points in geology.

—The Theory of the Origin of Species by Natural Selection.—In the last number of *Science* (Nov. 16, 1888) Mr. H. S. Williams, of Cornell University, publishes a letter, in which he says that Robert Bakewell gave "a remarkably clear conception of the elements of the theory which Charles Darwin has made famous, almost thirty years prior to the appearance of 'The Origin of Species.'"

At first he gives some notes about artificial selection by R. Bakewell, which contain nothing new; artificial selection having been use from the oldest historical times.

Then Mr. Williams continues, stating that Mr. Bakewell applied this principle to explain the appearance of new forms of Mollusca.

But Mr. Bakewell's remarks have nothing to do with *natural selection* whatever. He simply says that forms are changed when brought into different conditions.

This is Transformism or Lamarckism, but not Darwinism!

Mr. Williams seems to ignore the fundamental difference between these two theories, in spite of the numerous recent able discussions on this subject.—*G. Baur, Yale University Museum, New Haven Connecticut.*

—The late Prof. Edward Tuckerman made a choice collection of books and papers relating to Lichens, some four hundred numbers in all, which has been presented by Mrs. Tuckerman, in accordance with his own wish, to Amherst College Library. It is proposed to keep the collection by itself under the name of the "Tuckerman Memorial Library," and to make it worthy of the name, by making it as complete as possible in its own department. Supposing that some persons interested in this specialty might like to assist in maintaining and completing the collection (with the understanding that it is always available to public use), I wish to give opportunity for any who care to do so to contribute, either in money or in material (especially rare monographs that may have escaped Prof. Tuckerman's notice), to this memorial to a model scholar and scientist. Whatever money may be contributed will be kept as a fund of which only the income will be employed in making additions to the collection, or in repairs and rebinding. The sum of $1000 would probably suffice as such a fund.

Wm. I. Fletcher,
Librarian of Amherst College.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Boston Society of Natural History.—November 7, 1888.—Prof. H. W. Conn, of Wesleyan University, read a paper on "Insect Larvæ and their relation to the adults"; and Mr. S. F. Denton exhibited models of animals prepared from a new material possessing many advantages.

Biological Society of Washington.—The 131st regular meeting, December 1st, 1888.—The following papers were read: Dr. Th. Gill, "On the relations of the Psychrolutidæ"; Dr. C. Hart Merriam, "Description of a new Ground Squirrel from California"; Mr. F. W. True, "Remarks on the Deer of Central America," with exhibition of specimens; Prof. C. V. Riley, "Notes on the Economy of Thalessa and Tremex"; Prof. B. E. Fernow, "Causes of configuration of trees."

Natural Science Association of Staten Island.—*February 11th, 1888.*—On motion of Mr. Hollick the following preamble and resolutions were adopted:—

Whereas, Our attention has been called to the title of a bill recently introduced in the Assembly, designed to allow the shooting of robins on Long and Staten Islands during the month of October, and,

Whereas, Such legislation would be a gross injustice to our Island, and would be a source of needless cruelty and destruction to our birds.

Resolved, That the Natural Science Association of Staten Island earnestly protests against the passage of this or any similar legislation, which tends to convert our Island into a legal shooting ground for the idle persons of New York and vicinity; and

Resolved, That copies of this preamble and resolutions be transmitted to the newspapers of the county and to our representatives in the Legislature, with the request that they use their best efforts to defeat the bill in question.

Mr. L. P. Gratacap made the following remarks upon the "boiling springs":—

During the very cold weather which visited us in January, culminating on January 27, and lowering the average night temperature to within a few degrees of zero, while the thermometer registered 12°–15° F. as its maximum in the day, the temperature of a group of springs on the hillside, south of Castleton avenue and near Bement, was taken. There were found to range from 44° to 53° F., the colder water being due to a less rapid flow and conse-

quently longer exposure at the springs' vent to the atmospheric influence. These springs, known as the "Boiling Springs," doubtless arise from below the impervious beds of clay, which may be seen outcropping along the sides of the gulches in the neighborhood washed out by freshets. While it seems unlikely that they issue from such a depth as sixty or eighty feet, which is assigned by Guyot as the limits of the zone of invariable temperature at our latitude, it is quite certain that points of origin are deep seated and almost, if not entirely, removed from superficial influence. The observation of Mr. W. T. Davis upon the Summer temperature of the Clove Valley springs corroborates this. He found that to be from 53° to 54°; almost identical with the Winter temperature of these springs at the coldest period of the season. The water flowing with this elevated temperature nourished an abundant growth of the common fresh water alga (*Conferva vulgaris* Rab.), which in turn supported in its thick and confused clusters numerous diatoms and infusoria. The green stems of a species of Veronica, too immature for determination, flourished abundantly in the tepid rivulet escaping from the tiny pools, while within a few feet last Summer's grasses were frozen in a crust of ice.

Mr. Wm. T. Davis read a portion of a letter from Mr. Aug. R. Grote. The extract is as follows: In 1856 I found *Clematis ochroleuca* growing on Kellett's Hill, near Egbertville, on the Southern slope near the top. My specimens went to the late Hon. Geo. W. Clinton, botanist, of Albany. I also collected a specimen of the fork-tailed flycatcher, *Milvulus tyrannus*, near our farm of Hill Park, towards the south-west side of the Island.

March 10th.—Mr. Arthur Hollick read the following notes, illustrated by drawings and dried specimens:—

During the Autumn of 1881 a species of sedge was found in company with *Callitriche verna* and *Dichelyma capillaceum* growing on the bottom of one of the springs near the present site of the S. I. Water Supply Co. It was proliferous, and showed no signs of either perfect flower or fruit, but as it was rather late in the season a more favorable time was awaited in which to collect and study it. The spring was deep, with walled sides and a clean sandy bottom and was never known to freeze, even in the severest winter. The plant was entirely aquatic—no part of it ever growing to the surface of the water. During the succeeding year it was visited from time to time in the hopes of obtaining either the flower or fruit, but without success. Specimens were however collected with aborted proliferous spikes, and it was finally admitted provisionally by Dr. Britton and myself into the Flora of Richmond county, in the appendix for 1883-84, under the name *Heleocharis prolifera* Torr (?). Since then it has been kept under constant scrutiny, but has never been found with flowers, and we were forced to conclude that it did

not produce any. It was naturally with some trepidation that it was determined to be this plant, as its habitat is given by Chapman, in his "Flora of the Southern States" to be from Florida to N. Carolina, and from there to Staten Island seemed a very extensive jump for the plant to take, without any intermediate locality from which it could have spread. Within the past six weeks, however, we have received specimens from the neighborhood of Trenton, N. J., which is a little more encouraging. It is well also to bear in mind that the place which this southern plant secured from its home so far north is just such a one as we would expect, namely, a perennial spring, which never freezes and in fact which maintains a constant temperature throughout the year of about 53°. So far as known, it failed to secure a foothold at any other locality on the Island, and the specimens which are now in our herbaria are probably the only ones which will ever be seen from here, as the spring has become silted up and all signs of life obliterated.

I was interested to find the following note in Dr. Torrey's monograph on the Cyperaceæ of N. America, p. 315-16: "Among my undetermined Cyperaceæ is a species of Eleocharis from the Southern States, which I have never been able to obtain with mature fruit. * * * * The spike is ovate and compressed, but instead of producing flowers it throws out a tuft of long filiform peduncles or rather culms, one from the axil of each scale, which strike root into the mud or float on the surface of the water and likewise bear proliferous spikes. * * * * I am inclined to consider this species as distinct from any other described in this monograph. It may be distinguished by the name of *E. prolifera*."

Again, in the Columbia College Herbarium, accompanying a specimen labeled *E. prolifera*, is a note by Dr. Torrey, which reads: "This may be a state of my *Chætocyperus baldwinnii* and the plant referred to in Baldwin's notes. * * * *"

Careful comparisons have been made between our specimens and those in the Columbia College Herbarium, under the names *Heleocharis baldwinii* Torr. and *H. prolifera* Torr., but our material is too imperfect to definitely determine just where it belongs. The specimens, while showing the general characteristics of the abovementioned species differ in having a stiff jointed woody rachis, along which the spikes are arranged alternately, and at the summit of which they are closely appressed into a somewhat imbricated cluster. Several of the plants have also produced runners or stolons which bear the proliferous spikes at irregular intervals.

Mr. L. P. Gratacap presented a nest of the Baltimore Oriole, suspended from the branches of a cherry tree. One side of the nest had been supported by means of strands of worsted attached to a branch considerably above the main support, acting in the nature of a guy rope to steady the structure.

May 12th.—Mr. Wm. T. Davis read the following entomological notes of local interest. A very small straw-colored cricket was discovered last August on the borders of the salt meadow at Great Kill. It was chiefly observed on the stems and leaves of the "high tide bushes" (*Iva frutescens*), and was difficult to capture owing to its shyness. When stridulating the sound produced was quite metallic in tone and may be likened to that well-known silvery sound of oxygen escaping bubble by bubble in a water bottle. This insect has been identified as *Anaxipha exigua* Say., and seems to have never been reported before from north of Maryland.

The "earwig" (*Anisolabris maritima*), common several years ago on the shore of Camp Washington, before the advent of the railroad, as noted in the proceedings for January, 1887, was discovered the past Summer at the other end of the Island, on the shore at Tottenville. They live under stones and pieces of wood just at high water mark. On an open sandy spot near Tottenville a species of "tiger beetle" (*Cicindela modesta*), has been observed for the past several years, and last fall a few specimens were seen at Watchogue. These insects have been searched for at intervening points, where the same natural features are present, but have only been discovered at those mentioned.

A specimen of *Erebus odora*, the largest species of noctuid moth to be found on the Island, was presented to the Association. It was taken during last September while flying about a room, at New Dorp, by Miss M. Britton, and is in good condition. Two other specimens have been captured on the Island during the last few years in the month of July, one at "sugar" and the other in a barn. All of these moths are females, as indicated by the three frenula.

Mr. Samuel Henshaw reported the discovery of a wild rabbit's nest in a small pile of tobacco stems thrown out of a grape house. Its position was extremely exposed, the ground being perfectly bare of shrubbery, and workmen constantly employed near it during the day. The nest was small, about the size of an ordinary cocoanut and lined throughout with fur. It was visited by the mother at night only, who, when about to leave, concealed her four young by drawing the stems carefully over them. When the little rabbits were inspected at evening they uttered a faint cry, and if the hand was placed over them their heads bumped with much regularity against it, supposing no doubt that their mother had come to visit them. These inspections by curious visitors, and the danger from the family dog and cats that were constantly prowling about, caused the nest to be deserted and the young died when about two weeks old. The strong odor from the tobacco stems would greatly aid in protecting the nest from predatory prowlers, and it was suggested that the situation may have been chosen for this reason.

June 9th.—Mr. Samuel Henshaw submitted the following notes: The late spring of this year prevented the buds of the forest trees unfolding at their usual time, but when they did begin, their growth was astonishingly rapid. The horse chestnuts had finished their year's growth in nine days, the beech in about ten days, and other trees correspondingly rapid, as if nature was trying to make up for the delay. Indeed, I have noticed that no matter whether it is an early or late spring, by the first week in June all seasons are nearly alike.

The blizzard played queer freaks with the hardy trees; some Japanese maples, that have stood the last twelve years without any protection, have suffered—one is dead and the others have lost a few of their branches. Some of the hardy cypresses have lost all their leaves, and all the tall Lombardy poplars look in a very dilapidated condition, their long slender branches having been whipped by the strong winds, thereby rubbing off the latent buds. Some trees look as if the bark on the windward side had been polished, so great was the force of the beating with ice and snow.

Mr. Sanderson Smith gave an account of *Limax maxima*, which had accidently been omitted when preparing the recently published list of the Mollusca of the Island. The species is an introduced one, and was found some years ago by Mr. Powell at New Port. Mr. Prime and Mr. Smith had discovered it in a cellar in Fourteenth street, N. Y., and at York, Penn., it had been observed feeding on potatoes It has been found in numbers in cellars and cisterns on Staten Island.

Mr. Arthur Hollick gave a brief account of the plants which have been found growing independent of cultivation on Staten Island, of which the following is an abstract:—

Although the plants of the Island were catalogued in 1879, and four appendices subsequently issued, yet there are many facts to be gleaned from these lists which are not generally appreciated and are of considerable interest. Thus, there are 1,264 species and varieties enumerated, all of which are in our herbarium, with the exception of about 30, which have not yet been collected, although reported upon good authority. These species are distributed among 511 genera and 111 families. 1225 are Phanerogams or flowering plants and thirty-nine are the higher Cryptogams—ferns and their allies. The Angiosperms number 916, of which 377 are Polypetalous, 405 are Gamopetalous and 134 are Apetalous. The Gymnosperms number six. The Dicotyledones number 916 and the Monocotyledones 303.

If they are divided roughly into herbs, shrubs and trees, we have 1,094 herbs, eighty-eight shrubs and seventy-two trees. Considering them as native and introduced the numbers are about 1039 native and 225 introduced. The largest family is Compositæ, with its fifty-

one genera and 148 species. These latter include twenty-seven Asters and nineteen Golden-rods. Grasses—forty-three genera and 115 species, including nineteen Panicums. Cyperaceæ or sedges—ten genera and eighty-one species, including forty-three Carex. Leguminosæ—twenty-one genera and fifty-four species. Labiatæ—twenty-five genera and forty-eight species. Rosaceæ—thirteen genera and forty-seven species. Caryophylleæ—fifteen genera and thirty-eight species. Scrophularineæ—thirteen genera and thirty-two species. Ericaceæ—fifteen genera and thirty-one species, including eleven which are picked under the common name of "Huckleberry." Cruciferæ—fourteen genera and thirty-one species. Ranunculaceæ -thirteen genera and thirty-one species. Polygonaceæ—three genera and twenty-seven species, including nineteen Polygonums. Lilaceæ—sixteen genera and twenty.five species. Orchidaceæ—twelve genera and twenty-four species. Umbelliferæ—seventeen genera and twenty-two species. In the Ferns we have thirteen genera and twenty-eight species. There are twelve Violets, twelve Oaks, eleven Willows, five Hickories and four Pines. Amongst the large number of plants worthy of particular mention is the *Clematis ochroleuca* Ait., of which an account was given in the proceedings for June 11th, 1887. The "Crane-fly Orchis," (*Tipularia discolor* Nutt.), although accounted a very scarce plant, is abundant throughout nearly all our deep wet woods. Almost without exception all the most troublesome weeds have been introduced, such as the "Pig weeds," "Wormseeds," "Amaranths," "Crab grass," "Wild Carrot," "Ox eye Daisy," etc. Some of the worst weeds have spread so rapidly in recent years that although they are already pests yet no common name has been invented for them. For instance, I can well remember when the first few plants of *Galinsoga parviflora* Cav., made their appearance in this region. It is now to be found nearly everywhere at this end of the Island and is spreading with amazing rapidity. "Trailing arbutus" has almost become a thing of the past, although a few patches still exist, which have not yet been destroyed by "arbutus parties." General memoranda upon our flora will be found in the proceedings for June 13th, 1885, and an account of our forest growth and the few large trees yet remaining, in the proceedings for February 12th and March 12th, 1887. Memoranda have been accumulating since the fourth appendix to the flora was issued, which will probably necessitate a fifth appendix at the end of the present season, so that it will be seen that the work of the botanical collector on Staten Island is not by any means completed, especially when it is remembered that most of the lower orders of cryptogams have hardly been touched. The Diatoms are, however, being catalogued by Mr. E. A. Schultze, and a list of the sea weeds by Mr. Nicholas Pike, is ready for the printer, while a good preliminary list of the mosses

is in preparation; but the Liverworts, Lichens, Desmids, Fungi and Protophytes await the future botanist's attention.

October 13th.—Mr. Wm. T. Davis presented natural-sized drawings of leaf forms and fruit of the hybrid oaks found near Richmond Valley, with the following further remarks upon the same:—

Since the September proceedings were printed, the oaks near Richmond Valley have been visited several times by Mr. Hollick, Mr. Gratacap and myself, and they have proved of so much interest that a detailed description of at least some of the trees may be worthy of record.

Nineteen oaks have so far been discovered, each tree having a sort of individuality, and their consideration with a view to clearing up the mooted points is no easy matter, but one that will at least require an extended period of careful observation.

Some leaves represent what has been considered as *Quercus heterophylla*, and are from the tree which I first discovered while looking for willow oaks on the 15th of last July. It is two feet three inches in circumference and about forty feet high. The fruit was not plentiful this Fall. One leaf is the most common type, and there are some without any lateral bristles.

There are eight additional trees greatly alike, and each one, as has been remarked, shows individual character, but a general resemblance in branching, foliage and acorns runs through them all. The leaves are not glossy on the upper surface, but in a few of the trees are slightly downy on their under side, along the mid-rib. The character and position of these oaks would indicate that *Q. phellos* with *Q. palustris* are the parents and this latter tree abounds in the locality. The largest willow oak in the wood stands close to an equally big swamp oak and a typical *heterophylla* about six feet high is growing up within two or three yards of their trunks. This little tree is several hundred feet away from the others of its kind.

In *heterophylla* the average diameter of the empty cups is about three m. m. more than *palustris* and the heighth of the nut is also greater in comparison to its breadth. In *phellos* the acorns are still smaller than in *palustris*, but it is an interesting fact that the proportions come closer to those of *heterophylla*. In Chambers, Encyclopædia it is stated that in hybrids "valuable results are often obtained as to size and abundance of fruit."

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